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ABSTRACT

This curriculum guide is designed to assist industrial arts teachers, counselors, and administrators in improving instruction in the areas of electricity and basic electronics. Included in the first part of the guide are a course flow chart, a course description, a discussion of target grade levels and prerequisites, course goals and objectives, an introduction, and a course outline. The next major section is a unit teaching guide consisting of units on the following topics: safety, mathematics skills, the nature of electricity, meters and measuring, residential electricity, direct-current circuits, magnetism, test equipment, alternating-current circuits, semiconductors, electronic devices, circuit fabrication, computers, robotics, industrial electricity and electronics, and careers. Appended to the guide are sample tests, a tool list, information on fire extinguishers, safety recordkeeping forms, a math review, formulas and conversions, worksheets on Ohm's Law and the Power Law, a tool identification sheet, instructions on house wiring and reading meters, sample lab exercises, and information sheets on robotics and the effects of current on the body. (MN)

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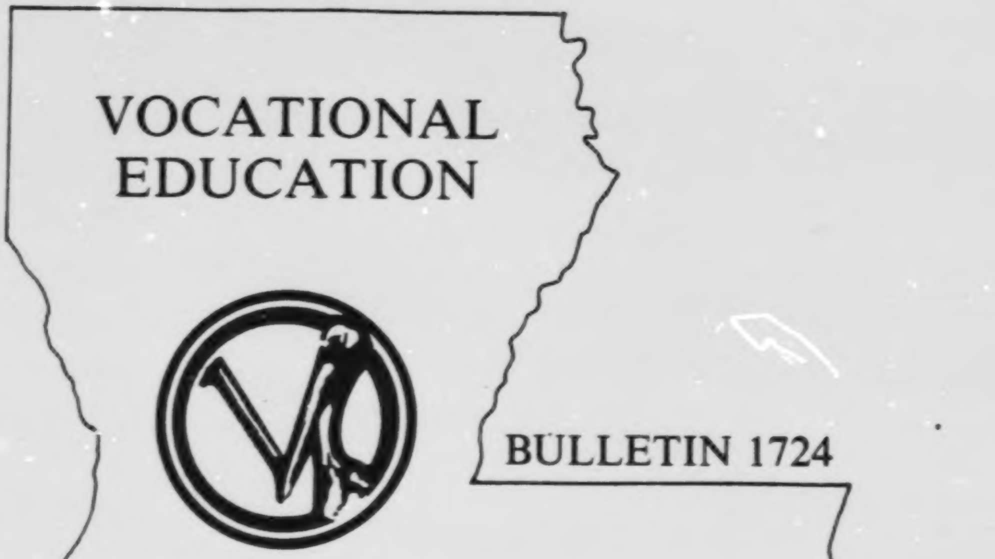
BASIC ELECTRICITY/ELECTRONICS

(Industrial Arts)



VOCATIONAL EDUCATION

BULLETIN 1724

CURRICULUM GUIDE

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State Superintendent

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FOREWORD

This publication is a guide for the improvement of instruction in Industrial Arts Education for the State of Louisiana. It should be of benefit to industrial arts teachers, supervisors, counselors, and administrators. These operational guidelines will help local administrators, teacher educators, and industrial arts teachers determine the extent to which their programs are meeting the needs of our youth. Industrial Arts Education Programs must be organized to meet the needs of all students.

A constant concern for educators is the construction and revision of curriculum. Industry and technology are the core of industrial arts instruction. Both are constantly changing; therefore, a curriculum and instruction must change in order to provide students a realistic and accurate understanding of industry and its function in our complex technological society.

Thomas G. Clausen

Thomas G. Clausen
State Superintendent of Education

ACKNOWLEDGEMENTS

This publication represents the cooperative efforts of personnel in the Louisiana Industrial Arts Association and the Industrial Arts Section in the Office of Vocational Education, Louisiana State Department of Education. Special recognition goes to Dr. Thomas L. Eppler, Northwestern State University, who was the Project Director in the development of the guide. Special commendation goes also to the following writing team members who worked diligently to produce this guide: George W. Fisher, Duane D. Dunlap, and Johnny O. Hamilton.

Elaine Webb, Ed.D.
Assistant Superintendent
Office of Vocational Education

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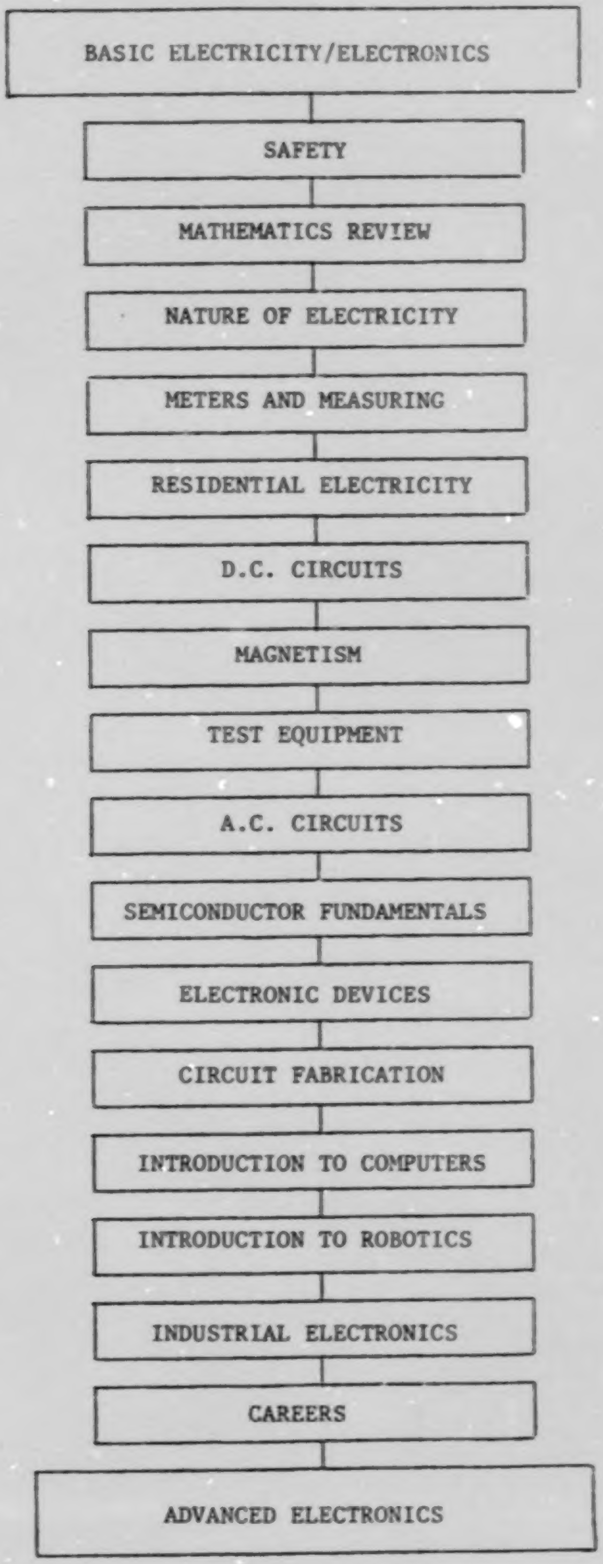
BASIC ELECTRICITY/ELECTRONICS
SAFETY
MATHEMATICS REVIEW
NATURE OF ELECTRICITY
METERS AND MEASURING
RESIDENTIAL ELECTRICITY
D.C. CIRCUITS
MAGNETISM
TEST EQUIPMENT
A.C. CIRCUITS
SEMICONDUCTOR FUNDAMENTALS
ELECTRONIC DEVICES
CIRCUIT FABRICATION
INTRODUCTION TO COMPUTERS
INTRODUCTION TO ROBOTICS
INDUSTRIAL ELECTRONICS
CAREERS
ADVANCED ELECTRONICS

Title:

Basic Electricity/Electronics

Course Description:

Basic Electricity/Electronics is designed as a one year introductory course and requires no previous knowledge of electricity or electronics. The course content is designed to make the student aware of the intricate relationship between our highly technological society and the fields of electricity and electronics. The student will gain a working knowledge of relevant theories and physical laws and their application. An awareness of practical devices will also be developed. The student will also gain practical hands-on learning experiences through the design, fabrication and testing of electrical and electronic circuits and devices.

Target Grade Level:

This course is designed for students in grades 10, 11 and 12.

Prerequisites:

General Industrial Arts (Algebra I desirable)

Course Goals:

In Basic Electricity/Electronics the student will become acquainted with the fields of electricity and electronics and their impact on society. The student will be exposed to the skills, techniques, tools, materials, and information related to electricity and electronics. The student will also be aware of the occupational and educational opportunities available upon completion of this course.

Course Objectives:

1. To develop in the student working knowledge of electricity and electronics.
2. To provide each student with the opportunity to explore those aspects of electricity and electronics that best meet his/her needs, aptitudes, or interest.
3. To provide the student an opportunity to apply science and math skills to practical situations.
4. To develop in the student the basic skills in the proper use of tools and equipment.
5. To develop in the student problem solving abilities and critical thinking.
6. To develop in the student a safety conscious attitude and safe work habits.

7. To provide the student the opportunity to explore occupational and educational opportunities in electricity, electronics, and related fields.

8. To develop in a student an awareness of the diverse nature of the field of electronics and its impact on society.

9. To inform the student so that he may become a wise consumer of electronic goods.

Introduction:

We are presently living in an electronic age. Electrical and electronic equipment warm and cool our homes, provide us light, entertain us, and make our work easier while making us more productive. In order to be wise consumers of electricity and wise users of electrical devices one must have some background knowledge in electricity. A substantial knowledge of electronics will assist the student in succeeding in future careers in Electricity/Electronics and many other areas.

This course was designed to provide the student with exposure to many areas of Electricity/Electronics. This exposure is broad-based though certainly not all inclusive. An in-depth study of more significant areas has been included so that depth of understanding may be achieved as well. This course was designed to be as technologically up-to-date as possible. However, the teacher should feel free to add material to this curriculum as changes in the state-of-the-art make additions necessary.

TIME FRAME

Hours		
5	Unit 1	Safety
5	Unit 2	Math Review
15	Unit 3	Nature of Electricity
5	Unit 4	Meters and Measuring
25	Unit 5	Residential Electricity
22	Unit 6	D.C. Circuits
8	Unit 7	Magnetism
8	Unit 8	Test Equipment
17	Unit 9	A.C. Circuits
5	Unit 10	Semiconductor Fundamentals
20	Unit 11	Electronic Devices
5	Unit 12	Circuit Fabrication
5	Unit 13	Introduction to Computer Literacy
5	Unit 14	Robotics: An Introduction for Your Classroom
10	Unit 15	Industrial Electricity/Electronics
3	Unit 16	Careers

Total - 163 hours. The remaining 17 hours can be used for opening and closing school, projects, school activities or to place extra emphasis where the instructor deems necessary.

ELECTRICITY/ELECTRONICS

A COURSE OUTLINE

I. ELECTRICITY AND ELECTRONICS SAFETY

A. Personal Safety Practices

1. State safety laws
2. OSHA
3. Electric shock
4. Protection
5. Effect of current on human body
6. Housekeeping

B. Safety Hazards

1. Hazardous conditions
2. Ground fault
3. Live circuits
4. Chemicals
5. Class of fires

C. Color Codes

1. Red
2. Yellow
3. Green
4. Orange
5. Purple

D. Mechanical Safety Tools

1. Hand tools
2. Power tools
3. Meters
4. Ladder use

E. Emergency Procedures (First Aid)

1. Bleeding
    a. Blood spurts
    b. Blood flows
    c. Blood oozes
2. Breaks or fractures
    a. Simple fractures
    b. Compound fractures
3. Open wounds
    a. Minor cuts and abrasions
    b. Serious wounds
    c. Puncture wounds

4. Electrical shock
    a. Shut off the current quickly.
    b. Remove the victim.
    c. Check heart and lungs.
    d. Apply artificial respiration if necessary.
5. Equipment failure
    a. Wrong size or type
    b. Motor-driven equipment
    c. Portable electric tools
    d. Overloading
    e. Failure to positively lock out
    f. Disconnecting of electric cords
    g. Test equipment
6. Fire.

II. MATHEMATICS REVIEW

Unit Objective - To review with students the mathematic skills needed in Electronics

A. Fractions

1. Addition of fractions
2. Subtraction of fractions
3. Multiplication of fractions
4. Division of fractions

B. Division of Decimal Numbers

1. Determining decimal place
2. Rounding off to desired place

C. Multiplication of Decimal Numbers

D. Scientific Notation

1. Expressing numbers in scientific notation
2. Converting scientific notation expressions
3. Adding and subtracting numbers expressed in scientific notation
4. Multiplying and dividing numbers expressed in scientific notation

E. Unit Prefixes

1. Prefixes
2. Abbreviations
3. Value
4. Conversions

F. Basic Algebra

1. Solving equations
2. Transforming equations
3. Algebraic substitutions

G. Calculating Square Roots (optional)

1. Square roots of decimal numbers
2. Square root of numbers in scientific notation

III. NATURE OF ELECTRICITY

A. Energy and Work

B. Structure of Matter

1. Compounds
2. Elements
3. Atoms
4. Subatomic particles

C. Electric Fields

1. Ions and ionization
2. Static electricity
3. Law of charges
4. Measuring charges
5. Industrial applications

D. Electrical Current

1. Electron current
2. Ion current
3. Measuring current

E. Conductors and Insulators

1. Properties of conductors
2. Properties of insulators

F. Electrical Potential

1. Determining electrical potential
2. Measuring electrical potential
3. Producing electrical potential

G. Resistance

1. Specific resistivity
2. Resistance and its measure

H. Ohm's Law

I. Power

1. What is power
2. Relation to voltage and current
3. Measuring power
4. Relationship to energy

IV. METERS AND MEASURING

A. Reading Meters

1. Analog meters
    a. Linear scale
    b. Logarithmic scale
2. Digital meters

B. Using Meters

1. Ammeters
2. Voltmeters
3. Ohmmeters
4. Multimeter
5. Meter error
    a. Loading
    b. Parallax error

C. Meter Care

1. Handling the meter
2. Setting and adjusting meters

V. RESIDENTIAL ELECTRICITY

A. Safety (Review from Topic I on safety)

1. First aid
2. Hazards
3. Personal
4. Grounding
5. Tools and equipment
6. Fires

B. Transmission and Distribution

1. Generating plant
2. High voltage transmission
3. Sub-station
4. Low voltage residential

C. Tools and Equipment--Basic

1. Screwdrivers
2. Pliers
    a. Long nose
    b. Bent nose
    c. Lineman (side cutters)
    d. Diagonal
3. Electrician's hammer
4. Wire strippers
    a. Adjustable
    b. Multipurpose
5. Rule
6. Wrenches
7. Threading tools
8. Awl
9. Drills
    a. Brace and bits
    b. Drill motor and bits
10. Saws
    a. Hack
    b. Hole
    c. Keyhole
    d. Reciprocal
11. Files
12. Soldering tools
    a. Soldering gun
    b. Soldering iron

D. Specialty Tools

1. Benders
    a. EMT
    b. Hickey
2. Pipe reamer
3. Pipe cutter
4. Plumb bob
5. Chisel
6. Knockout punches
7. Fish tape
8. Level
9. Meters
    a. Neon test light
    b. Volt-ohmmeter
    c. Ammeter
    d. Inductance couple meter

E. Wiring Equipment

1. Wire
    a. Cable types
    b. Sizing
    c. Insulation
2. Switches
    a. Single pole
    b. 3-way
    c. 4-way
    d. Dimmer
    e. Low voltage/push button
3. Receptacles
    a. Duplex 125v, 15 amp
    b. Dual voltage 125/250v, 20 amp
    c. Air conditioning 250 volt, 30 amp
    d. Range 125/250v, 50 amp
    e. Dryer 125/250v, 30 amp
4. Wall plate
5. Outlet boxes
    a. Handy
    b. Extension
    c. Octagon
    d. Square
    e. Box covers
    f. Switch
6. Conduit
    a. Rigid metallic
    b. Non-metallic
    c. Non-metallic sheathed
    d. Flexible conduit
    e. PVC
7. Electrical service
    a. Weather head or cap
    b. Race way
    c. Meter base
    d. Underground service
    e. System grounding
    f. Service entrance panel

F. Wiring Techniques

1. Electrical service
2. Rough-in
3. Branch circuit wiring
4. Finishing wiring

G. Load Determination

1. Current requirements
2. Lighting circuits
3. Speciality circuits

VI. DIRECT CURRENT CIRCUITS

A. Review of Ohm's Law

B. Series Circuits

1. Equivalent resistance
2. Voltage dividers
3. Kirchoff's voltage law

C. Parallel Circuits

1. Equivalent resistance
2. Current dividers
3. Kirchoff's current law
4. Conductance

D. Series-Parallel Circuits

1. Equivalent resistance
2. Voltage drops and current
3. Designing practical circuits

E. Advanced Analysis Techniques (Optional)

1. Bridge circuits
2. Mesh analysis
3. Delta-tee conversions
4. Loop analysis
5. Superposition
6. Thevenin and Norton networks

F. Capacitors

1. Capacitor action
2. Construction
3. Rating
   a. Working voltage
   b. Capacitance
   c. Tolerance
4. Types of capacitors

5. Transient response
    a. Charging the capacitor
    b. Discharging the capacitor
    c. Time constants
6. Capacitors in series
7. Capacitors in parallel

VII. MAGNETISM

A. History of Magnetism

B. Magnetic Theory

1. Domains
2. Poles, fields, and flux
3. Law of magnetism

C. Magnetic Materials and Effect

1. Ferromagnetic
2. Paramagnetic
3. Diamagnetic
4. Magnetic shielding

D. Measuring Magnetism

1. Magnetomotive force
2. Flux density
3. Intensity
4. Reluctance
5. Permeability

E. Electromagnetic Effect

1. Relation to current
2. Magnetism in coil of wire
3. Electromagnetism
    a. Cores
    b. Strength
    c. Polarity
4. Electromagnetic devices
    a. Solenoid
    b. Relays
    c. Circuit breakers
    d. Speakers
    e. Meters
    f. Bells and buzzers
    g. Recording tape

F. Inductance

1. Induced EMF
2. Lenz's law
3. Measuring inductance
4. Effect of cores
5. Quality of coils
6. Transient response
7. Inductance in series
8. Inductance in parallel

VIII. TEST EQUIPMENT

A. Meter Fundamentals

1. Analog/pointer type
   a. D'Arsonval
   b. Iron vane
2. Digital/LED or LCD type
   a. Analog to digital conversion
      (1) Ramp method
      (2) Dual-slope method
      (3) Switched-resistor method
   b. Counting
3. Voltmeters
   a. Multipliers and ranging
   b. Types of voltmeters and uses
      (1) Volt-Ohm Milliammeter/VOM
      (2) Electronic Voltmeters/EVM
   c. AC measurements
4. Ammeters
   a. Meter shunts and ranging
   b. Types of ammeters
      (1) D'Arsonval
      (2) Iron vane
      (3) Hot wire meter
   c. Connections
5. Ohmmeter
   a. Series
   b. Shunt

B. Oscilloscopes

1. Construction
2. Operation
   a. Function of controls
   b. Calibration

C. Function/signal generator

1. Function generator uses
2. Signal generator uses

D. Transistor Tester

IX. AC CIRCUITS

A. Alternating Current Fundamentals

1. Waveforms
   a. Sine waves
   b. Square waves
   c. Ramp waves
   d. Triangle waves
2. Quantifying alternating currents
   a. Frequency
   b. Period
   c. Wavelength
   d. Peak value
   e. Peak to peak
   f. Effective or root-mean-square (RMS) value
   g. Average value
   h. Instantaneous value
   i. Harmonics
3. Polyphase current
   a. Wave forms
   b. Uses
4. Voltage, current and power relationships

B. Capacitive Circuits

1. Reactance
2. Phase shift
3. Impedance
4. Apparent power
5. Graphic analysis techniques

C. Inductive Circuits

1. Reactance
2. Phase shift
3. Impedance
4. Apparent power
5. Graphic analysis techniques

D. Transformers

1. Mutual inductance - Lenz's Law
2. Physical construction
3. Turns ratio
4. Isolation and autotransformers
5. Multi-voltage transformers
   a. Tapped
   b. Multiple coils
6. Transformer applications
7. Power losses and efficiency

20

E. Tuned Circuits

1. Resonance
2. Series tuned circuit
   a. Impedance curve
   b. Frequency
   c. Bandwidth and selectivity
3. Parallel tuned circuits
   a. Impedance curve
   b. Frequency response
   c. Bandwidth and selectivity
4. Filters and filtering
   a. High pass
   b. Low pass
   c. Band pass
   d. Band reject
   e. Frequency response and crossover

X. SEMICONDUCTOR FUNDAMENTALS

A. Semiconductor Materials

1. Pure semiconductors
2. Low temperature characteristics
3. High temperature characteristics
4. Doping semiconductors
5. N-type material
6. P-type material
7. Current in semiconductors

B. P-N Junction

1. Forming the junction
2. Depletion region
3. Barrier potential
4. Forward biased
5. Reverse biased
6. Avalanche breakdown

XI. ELECTRONIC DEVICES

A. Diodes

1. Characterictics of diodes
2. Types of diodes
   a. Rectifiers
   b. Switching
   c. Zener
   d. Light emitting diode
3. Diode ratings

4. Rectifier circuits
    a. Half-wave rectifier
    b. Full-wave rectifier
    c. Bridge rectifier
    d. Rectifier packaging
    e. Diode clampers and limiters
5. Power supplies
    a. Filtering
    b. Regulation
    c. Voltage multipliers
    d. Voltage converters and inverters

B. Transistors

1. Bi-polar junction transistors
    a. Operating theory
    b. Types of bi-polar transistor
    c. Uses of transistors
    d. Basic circuits
    e. Fabrication techniques
    f. Operating parameters and conduction curves
    g. Transistor testing
2. Field effect transistors
    a. Junction field effect transistors
    b. Depletion mode metal oxide semiconductors
    c. Enhancement mode metal oxide semiconductors
    d. Fabrication techniques
    e. Operating parameters

C. Transistor Amplifier Circuits

1. Circuit types
    a. Common-base
    b. Common-collector
    c. Common-emitter
    d. Common-source
2. Biasing and load lines
3. Frequency response
4. Distortion
5. Coupling and feedback
6. Transistor driver circuits
7. Transistor switching circuits

D. Thyristors

1. Silicon controlled rectifiers
    a. Construction
    b. DC operation
    c. AC operation
    d. Applications

2. TRIAC
    a. Construction
    b. Operation
    c. Applications
3. DIAC
    a. Construction
    b. Operation
    c. Applications
4. Unijunction transistor
    a. Construction
    b. Operation
    c. Applications
5. Thyristor ratings

E. Integrated Circuits

1. Fabrication techniques
    a. Monolythic I.C.'s
    b. Large scale integration I. C.'s
    c. Hybrid
2. Properties and ratings
3. Applications
    a. Digital I. C.'s
    b. Analog I. C.'s
4. Operational amplifiers
    a. Operational amplifiers
    b. Differential amplifiers
    c. Applications

F. Thermistors

1. Negative temperature coefficient thermistors
2. Uses
    a. Thermal compensation
    b. Heat sensing
3. Positive temperature coefficient thermistors

G. Opto-Electric Devices

1. Uses
    a. Isolation
    b. Communication
    c. Safety
    d. Limit distortion
2. Types
    a. Light-activated SCR
    b. Opto-isolators
    c. Infra-red light-emitting diodes
    d. Light-activated transistors
    e. Photoresistors
    f. Lasers
    g. Light-emitting diodes

XII. CIRCUIT FABRICATION

A. Schematic Diagrams

1. Understanding component symbols
2. Breadboarding

B. Printed Circuit Board

1. Materials
    a. Copper electroplating
    b. Gold plating
    c. Tin-lead plating
    d. Tin-nickel plating
2. Printing
    a. PC board cleaning
        (1) Chemical cleaning
        (2) Degreasing
        (3) Acid dipping
    b. Photoresists
    c. Screen printing
    d. Contact print
    e. Rub-off transfer
3. Etching
    a. Etching solutions
    b. Equipment and techniques
    c. Etching safety
4. Drilling

C. Soldering

1. Fluxes
2. Alloys
3. Soldering techniques

D. Wire Wrapping

E. Point-to-Point Wiring

XIII. INTRODUCTION TO COMPUTERS

A. History of Computational Machines

B. Processing Information in a Computer

1. Central processing unit (CPU)
2. Read-only-memory (ROM)
3. Random access memory (RAM)

C. Hardware

1. Classes of computers
   a. Main frame
   b. Microcomputer
   c. Microprocessor
2. External memory devices
   a. Cassette
   b. Disc
   c. Hard disc
   d. Tape
   e. Card readers
3. Input/output devices
   a. Video monitors/CRT
      (1) Black and white
      (2) Green phosphorous
      (3) Color

   b. Modems
   c. Printers
      (1) Dot matrix
      (2) Daisy wheel
      (3) Continuous band/metal band
      (4) Ink jet
   d. Joystick and paddles
   e. Keyboards
   f. Voice synthesizers

D. Software

1. Programming languages
   a. Basic
   b. Pascal
   c. Fortran
   d. Cobol
   e. Assembler
2. Programming logic
3. Software sources
   a. Commercial
   b. User groups
   c. Self-generated

XIV. ROBOTICS: AN INTRODUCTION FOR YOUR CLASSROOM

A. What is Robotics

1. What is a robot
2. Components of a robot
   a. Manipulator
   b. Controller
   c. Power source

3. Work envelope

B. Types of Robots

1. Non-servo controlled
2. Servo controlled
3. Remote controlled

C. Robot Applications

1. Industrial
   a. Spot welding
   b. Arc welding
   c. Assembly
   d. Material handling
2. Industrial Arts
   a. Spot welding
   b. Arc welding
   c. Electronic component assembly
   d. Machine loading and unloading
   e. Line production activities
      (1) Finishing process
      (2) Material handling
      (3) Assembly
      (4) Quality control
   f. Research and development activities
   g. Metal casting processes
      (1) Pouring
      (2) Shake-out
      (3) Mold venting
   h. Laboratory experimentation

D. Social Economic Impact

1. What cybernetics means to industry
2. Productivity levels

XV. INDUSTRIAL ELECTRICITY/ELECTRONICS

A. Generators

1. Theory of operation
   a. AC generators
   b. DC generators
2. Basic construction
3. Types of generators
4. Applications

B. Motors

1. Theory of operation
   a. DC motors
   b. AC motors

2. Types of motors
    a. DC
    b. AC
3. Motor construction
4. Motor ratings
5. Application
6. Motor starters
7. Care and maintenance
8. Over-current protectors

C. Resistance Devices

1. Resistance heaters
2. Arc welding
3. Carbon arc
    a. Electric arc furnaces
    b. Carbon arc lamps
    c. Carbon arc welding

D. Electrochemical Reactions

1. Electrolysis
    a. Production of chemicals
    b. Metal reclamation
2. Electroplating
3. Metal refinement

E. High Frequency Heating

1. Induction heating
2. Microwave heating

F. Lamps and Lighting

1. Incandescent lamps
2. Ionized gas lamps
    a. Noble gasses
    b. Metal vapors

XVI. CAREERS

A. Engineering

1. Nature of work
2. Where employed
3. Employment outlook

B. Technician

1. Television
2. Radio
3. Communications

C. Utilities

   1. Power plant
   2. Transmission and distribution
   3. Consumer services

D. Telephone Companies

   1. Installers and repair specialists
   2. Operators
   3. Central office installers
   4. Line construction and maintenance

E. Manufacturing

   1. Managerial
   2. Technical
      a. Lab technicians
      b. Draftsmen
      c. Technicians
   3. Assembly
   4. Machining
   5. Fabricating
   6. Processing
   7. Testing

F. Construction Electricians

G. Maintenance Electricians

H. Broadcasting

I. Teachers

UNIT I: ELECTRICITY/ELECTRONICS SAFETY

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to introduce the importance of integrating safety as part of the Electricity/Electronics program. Students should be constantly reminded that safety must become an everyday consideration in this program and any industrial arts or vocational education laboratory. With safety the first unit of this curriculum, it is our intent for safety to be reviewed and taught in every unit of the curriculum that is necessary.	To make the student aware of the safety practices and hazards in working with electricity/electronics.	Upon completion of this unit, students should be able to: 1. Understand course content of personal and hazard safety. 2. Be familiar with first aid procedures. 3. Identify color codes. 4. Observe and comply with fire prevention practices. 5. Student must score at least 70 percent to pass unit test.

UNIT I: ELECTRICITY/ELECTRONIC SAFETY 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
At the conclusion of this unit, the student should be able to:	A. Personal Safety Practices	*Take notes	*Present student with charts and safety rules. Show film.	Self made or local teacher supply.
Develop responsible behavioral attitudes required for electronics/electricity.	1. State safety laws 2. OSHA safety laws 3. Electric shock	Explain electric shock and ways of prevention.		
Identify personal safety practices.	4. Current and its effects on the human body 5. Protection a. body (all parts) b. clothes c. jewelry	Discuss current and its effects on the human body at 120 volt, 60 hertz (cycle).	List laws on chalk board. *Chart of current and its effects on the human body.	(#35),p. 4 (#26),p. 211 (#24),p. 14
List personal protective devices. Explain importance of good housekeeping.	6. Housekeeping	Organize a clean up roster for housekeeping.	Make chart and explain duties.	(#30),p. 20 (#25),p. 7
Have a thorough understanding of electrical safety hazards and prevention measures.	B. Safety Hazards 1. Hazards condition a. wet area b. defective equipment c. reporting procedure	Discuss electrical hazards. List unsafe electrical conditions. List prevention for electrical hazards.	*Show films on safe and unsafe conditions.	(#35),p. 4 (#36),p. 47 (#26),pp. 208-212
List example of common unsafe acts that result in electrical accidents or injury.	2. Ground fault a. electrical tool b. safety device	Explaining grounding tools and devices.	Discuss grounding. Lead group discussion on live circuits and chemicals.	(#5),pp. 24-25 (24),p. 301 (#26),pp.195,206-207
	3. Live circuits 4. Chemicals a. group A atmosphere b. group B atmosphere c. group C atmosphere d. Group D atmosphere	Discuss the proper procedure for working around live circuits. Name some chemicals. Groups		(#21) Article 500
Identify appropriate types of fire extinguishers. List the location of fire alarms and explain the proper procedure to evacuate the lab/classroom in case of fire.	5. Fire safety a. fire extinguishers (1) types (2) use (3) maintenance	Practice evacuation of lab/classroom in case of fire. List the location of fire alarms and extinguishers.	Hold classroom fire drills and discuss class of fires. *Chalkboard	
	b. class of fires (1) class A (2) class B (3) class C (4) class D	Match the fire with the proper extinguisher.		Local fire station, invite a fireman to speak to class.
		*Use your notebook.	*Use charts, overhead projector, and transparencies.	

UNIT I: ELECTRICITY/ELECTRONIC SAFETY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Identify each color code.	C. Color Codes 1. red 2. yellow 3. green 4. orange 5. purple	Define and discuss tools, machines, equipment, and apparatus with color code section.	Explain where each color of the color code will be found. *Chalkboard	(26),p. 5
Identify safety factors for all electrical tools. List the most common unsafe acts.	D. Mechanical Safety Tools 1. Hand tools a. appropriate tools for the job b. good condition 2. Power tools a. all power tools should be grounded b. excessive pressure should never be used with portable electrical tools c. extension cord (1) plugging (2) disconnect	List electrical/hand/power tools in notebook with safety rules. Discuss tool safety.	Demonstration of safe and correct use. Stress grounding of power tools.	(#36),pp. 15-27 (#22),pp. 370-373
Identify the types of electrical meters and their safety rules.	3. Meters a. ammeter b. voltmeter c. ohmmeter d. multimeter e. wattmeter f. digital multimeter	Hands on experience with meters. Safety do's and don't. Proper way to test equipment. Observe polarity in dc circuit. Selecting the dc ranges.	Identify the proper connection of polarity and ranges. Show film.	(#24),pp. 207-213 (#5),pp. 83-84 (#13),pp 153-154 Films on meters.
List the common unsafe acts of ladder use.	4. Ladders a. step ladders b. extension	Discuss ladder and safety.	Discuss parts and safe use.	
			*Use charts, overhead projector, and transparencies.	

UNIT I: ELECTRICITY/ELECTRONIC SAFETY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Understand the responsibility of emergency procedures. Identify when to act, and how to act.	E. Emergency Procedures 1. Bleeding a. blood spurts b. blood flows c. blood oozes 2. Breaks or fractures a. simple fractures b. compound fractures 3. Open wounds a. minor cuts and abrasions b. serious wounds c. puncture wounds 4. Electrical shock a. shut off the current b. removing victim c. artificial respiration	Discuss emergency procedures and some general first aid.	Identify bleeding, breaks, wounds, and electrical shock.	Invite a nurse to speak to students. School library first aid information.
Identify equipment failure and take appropriate precautionary action.	5. Equipment failure a. wrong size or type b. overloading c. test equipment d. extension cords	List unsafe electrical conditions that could lead to equipment failure.	Discuss unsafe electrical conditions stated by student.	(#23),pp. 15-20 (#10),p. 371 (#24),pp. 207-213 Invite the school maintenance supervisor to speak in class.
	F. Review Unit	Work study sheet	Review unit for test. Simple questions.	Teacher made test.
Student must make 70 percent to pass.	G. Test on Unit	Test on unit.		
		Review test.	Review test.	

UNIT II: MATHEMATICS REVIEW

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is designed to review with the student those mathematical skills that will be used in this course. Proficiency in these areas is essential for success in electricity/electronics. Special attention should be paid to operations involving unit prefixes as they are widely used throughout electricity/electronics texts and literature.	The goal of this unit is to review with the students the mathematical skills that will be applied throughout this course.	Upon completion of this unit the student will be able to: 1. Perform arithmetic function on fractions, whole numbers and decimal numbers. 2. Express numbers in scientific notation or by use of unit prefixes and be able to convert from one prefix to another. 3. Use rules of basic Algebra to solve equations. 4. Determine the square root of a number. 5. Student must score a minimum score of 70 percent on a unit test.

UNIT II: MATHEMATICS REVIEW 5 Hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to perform arithmetic functions on fractions, scoring a minimum of 75 percent on unit test.	A. Fractions 1. Expressing numbers as fractions 2. Finding common denominators 3. Adding fractions 4. Subtracting fractions 5. Multiplying and dividing fractions	Worksheets on all areas to review and practice skills See Appendix #5	Demonstrate each skill to students.	(#37),p. 295 (#37),pp. 313,315 (#37),pp. 307,310
Students will be able to multiply and divide decimal numbers to 10 thousandths place and point off correctly.	B. Dividing Decimal Numbers 1. Determining decimal place 2. Rounding off			
	C. Multiplying Decimal Numbers			
Students will be able to express numbers in scientific notation in scientific notation and correct numbers expressed in scientific notation as decimal number.	D. Scientific Notation 1. Expressing decimal numbers in scientific notation 2. Converting numbers in scientific notation to decimal numbers			
Students will be able to add, subtract, multiply and divide numbers expressed in scientific notation.	3. Converting two numbers in scientific notation to the same power 4. Adding and subtracting numbers expressed in scientific notation 5. Multiplying and dividing numbers in scientific notation			(#37),p. 291 (#12),p. 26
Students will be able to name unit prefixes, give their values and convert from one unit prefix to another.	E. Unit Prefixes 1. Prefixes and their value 2. Prefix symbols and abbreviations 3. Converting to prefixed units 4. Converting to basic units from prefixed units 5. Converting prefixed units to prefixed units			(#12),p.27

UNIT II: MATHEMATICS REVIEW (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to solve equations for a given variable.	F. Basic Algebra			
	1. Solving equations by the multiplication property of equality			(#37),p. 123
	2. Solving equations by the division property of equality			(#37),p. 125
	3. Transforming equations by division or multiplication			
Students will be able to use substitution principle in deriving equations.	4. Substitution of one value for another in an equation			(#37),p. 113
Students will be able to calculate the square root of a number to the thousandths place.	G. Square Roots			
	1. Square roots of whole numbers			
	2. Square roots of decimal numbers			
	3. Square roots of numbers in scientific notation			
	H. Unit Review			
	I. Unit Test			

UNIT III. NATURE OF ELECTRICITY

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is intended to familiarize industrial arts students with the nature of electricity and to define electronics.	To provide students with the fundamental knowledge of matter that allows electricity to exist.	Upon completion of this unit, students should be able to: 1. Define electronics and to list five different fields into which the broad field of electronics is divided. 2. Define DC, AC, molecule, element, atom, electron, proton, neutron, nucleus, and ion. 3. Define conductors and insulators and explain where they are used. 4. Define electrical quantities of charge, voltage, current, resistance and power and mathematically relate them.

UNIT III. NATURE OF ELECTRICITY 15 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
At the conclusion of this unit, the student should be able to: Identify matter in three different states. Understand basic building materials from which all matter is constructed.	A. Energy and Work B. Structure of Matter 1. Elements 2. Compounds 3. Atoms 4. Subatomic particles C. Electrical Fields 1. Ions 2. Static electricity 3. Law of charges 4. Measuring charges 5. Industrial use	*Note taking (in notebook) Define properties of matter. Name some compounds. List some elements. Draw a schematic diagram of an atom of hydrogen, etc. Discuss electrical fields. List and define types of static electricity. Name types of charges.	Lecture: *List properties to be defined. Check work on compounds and elements. *Demonstrate static electricity.	(#12),pp. 7-8 (#5),pp. 4-5 (#12),p. 5 (#24),pp. 1-23 (#21),pp. 1-17& 1-118
Display awareness of electrical current and properties.	D. Electrical Current 1. Electron 2. Ion 3. Measuring current	Explain the flow of electrical charge from one point to another. Discuss current flowing past a point, in a specific length of time.	*Discuss electrical current.	(#5),pp. 89-90 (#21),pp. 8-6, 8-10
Develop a working knowledge of good conductors and insulators.	E. Conductors and Insulators 1. Good conductor materials 2. Good insulators	Explain substances which have large numbers of free electrons and very few free electrons.		
Understand the function of a capacitor and how electrical potential is measured.	F. Electrical Potential 1. What is electrical potential 2. Measuring electrical potential 3. Producing electrical potential	Discuss the holding of electricity and how it is measured.	Discuss electrical potential. Describe sources of electricity.	(#24),pp. 115-118
Identify the roles of resistance in circuits: Describe how the length, cross sectional area, resistivity and temperature of a substance effect its resistance.	G. Resistance 1. Specific resistivity 2. Measure resistivity 3. Resistors a. kind b. rating c. color code	Explain how resistance limits the flow of electrons through a circuit.	*Describe resistance. *Use charts, overhead projector, and transparencies.	(#12),pp. 21-23 (#5),pp. 49-50

UNIT III: NATURE OF ELECTRICITY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
State Ohm's law. Write three equation forms of Ohm's law.	H. OHMS Law 1. Deriving Ohm's law 2. Using Ohm's law	Study the formulas: For voltage (E or V) For current (I) For resistance (R)	Give student work sheet for problem solving.	(#5),pp. 64-66 (#12),p. 22 (#24),pp. 16-17
Understanding electrical power, verify the three power equations.	I. Power 1. What is power 2. Relation to voltage and current 3. Measuring power 4. Relationship to energy	Practice problems as directed by teacher. Discuss three common equations for determining the power in a circuit.	*Identify power. Pass out review sheet.	(#24),pp. 20-22
	J. Review Unit	Test review		
	I. Test	Test		
			*Use charts, overhead projector, and transparencies.	

UNIT IV: METERS AND MEASURING

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to introduce the student to meters and measuring.	The student should be familiar with most types of meters and able to read the scale of that meter.	Upon completion of this unit the student should be able to: 1. Identify several types of meters. 2. Describe the operation of a multimeter. 3. Know the functions of and how to use both DC and AC meters. 4. Know the function of and how to use voltmeters, ohmmeters, and digital meters.

UNIT IV. METERS AND MEASURING 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
At the conclusion of this unit the student should be able to: Interpret the reading of all meters and scales. Understand the operation of the digital meter and how to use it. Identify the functions and how to use an ammeter.	A. Reading Meters 1. Analog meters a. linear scale b. nonlinear scale 2. Digital meters a. reading numbers on a cyctal display b. five AC & DC voltage and current ranges	*Use notebook (note taking) Identify and read scales of an analog meter. Draw type of scale. List the function of a digital meter.	*Demonstrate how the meters are read. Identify parts and controls.	(#18),Unit 6, pp. 8-10
	B. Using Meters 1. Ammeters a. accuracy range b. accuracy fall off c. connection	List ways in which you can use an ammeter. Include the operation.		(#10),Unit 6, pp. 16-17
Identify the functions and how to use a voltmeter.	2. Voltmeter a. one milliamperes use as a voltmeter b. multi-range voltmeter c. connection	*Use notebook (note taking) Discuss operation and the reading of the voltmeter.	Demonstrate proper meter handling and use.	
	3. Multimeter a. combination of meters b. all meters have similar controls	List functions that can be performed with a multimeter.		(#18),Unit 6, pp. 30-32
	4. Ohmmeters a. probes b. zero adjust c. connection			(#18),Unit 6, pp. 41-43
Identify meter error and ways to correct them.	5. Meter error a. loading error b. parallax error	Observe pointer image in a mirror.	Explain meter error.	
			*Use charts, overhead projectors, and transparencies.	

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Identify safety rules and cares in using meters.	C. Meter Care 1. Handling meters a. probes b. proper movement 2. Connecting meters 3. Setting and adjusting	Review safety (included). List procedures used in connecting meters, testing for full-scale deflection.	Propose questions about meter care after safety review on meters.	
	D. Unit Review	Test review	*Pass out review sheet.	
	E. Unit Test			
			*Use charts, overhead projector, and transparencies.	

UNIT V: RESIDENTIAL ELECTRICITY

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL (S)	GENERAL UNIT OBJECTIVES
This unit is intended to familiarize the learner with residential electricity. The student will perform jobs, techniques, applications, and service installations. Teachers should be aware of the importance of using the correct nomenclature, as well as the need for thoroughness in initial demonstration.	Students will be given the opportunity to explore, identify, and understand a variety, of techniques, through handling tools, materials, and meters.	Upon completion of this unit, students should be able to: 1. State or list safety precautions to be observed when working with electricity. (Tool, circuit, etc.) 2. Demonstrate an understanding of load per circuit. 3. Identify material used in house wiring. 4. Pass unit test with a score of 70 percent or better.

UNIT V: RESIDENTIAL ELECTRICITY 25 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
At the conclusion of this unit the student should be able to discuss the importance of safety.	A. Safety 1. First aid 2. Hazard 3. Personal 4. Grounding 5. Tool and equipment 6. Fires	*Use notebook (note taking) Review rules that apply to house wiring from unit one.	*Stress safety rules that apply to house wiring.	(#35),pp. 12-552 (#36),pp. 3-14 (#27),pp 517-14 and 210-8 (#27),p. 250-45 (#36),p. 7
To understand the transmission of electricity from generating plant to home or large factories.	B. Transmission System 1. Generating plant a. step up substation b. transformer 2. High voltage transmission a. large factories and stores b. transformer 3. Low voltage a. residential and small stores b. step down transformer	Discuss the need and importance of electricity. Sketch a diagram of the delivery of electricity from a generating plant to a home.	Lecture the transmission system of electricity from the generating plant to home.	Invite a lineman to speak to class. (#24),pp. 187-193 (#36),pp. 132-135
	4. Household electrical system (planning) a. make blueprint b. symbols	Draw plans for house wiring.		(#31),p. 275 (#20),pp. 365-368 (#20),pp. 189-192
At the conclusion of this unit the student should be able to:	C. Tools and Equipment (Basic) 1. Screwdrivers	*Use notebook (note taking) Discuss the use of tools.	*Stress the right tool for the right job.	(#36),pp. 15-28
Identify common hand tools used in electrical wiring. Know safe use of hand tools and specialty tools.	a. flat blade b. phillips (cross point) c. stubby 2. Pliers a. long nose b. bent nose c. lineman pliers d. diagonal e. groove joint f. combination	Use tools to perform simple tasks involved in house wiring.	*Demonstrate and identify the parts of each tool.	(#24),pp. 370-373
			*Use charts, overhead projectors, and transparencies.	

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	3. Electrician hammer 4. Wire strippers a. cable b. multipurpose c. adjustable			
Understand the units of measurement.	5. Rule a. tape measure (retractable) b. folding 6. Wrenches a. Allen b. open end c. box end d. adjustable 7. Threading tools 8. Punch and awls 9. Drill and bits a. brace and bits b. drill motor and bits 10. Saws a. hack b. hole c. keyhole d. reciprocal 11. Files a. double cut b. single cut	Practice by measuring objects in the classroom.		(#36),pp. 144-148
Identify the techniques of soldering and using a soldering iron or gun.	D. Specialty tools 1. Soldering a. iron b. pencil c. gun	Discuss the material used in soldering: flux acid flux rosin core tin and lead	*Demonstrate by showing material for soldering.	
			*Give measuring problem to class. *Use charts, overhead, projectors, and transparencies.	

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	2. Pipe reamer 3. Pipe cutter 4. Benders a. EMT b. Hickey c. heater (Plastic) 5. Plumb bob 6. Chisel 7. Knock out punches 8. Fish tape 9. Level	*Use notebook (note taking) Name the purpose or use of each tool.		
Explain the application of meters in house wiring.	10. Meters a. necn test light b. volt ohmmeter c. ammeter d. multimeter e. inductance couple meter	Review Unit IV, Meters and Measuring. Identify each meter and its purpose.	*List the name of meter on the chalkboard or handout sheet.	
At the conclusion of this unit, the student should be able to: Understand the purpose of insulation for wire.	E. Wiring Equipment 1. Wire a. cable type b. size c. insulation	List the different types of wire and size. Identify the most common use of each type of wire.	Lecture: Use simple wire for student to identify.	(#36),pp. 163-165 (#24),pp. 197-198
Name the types of switches and receptacles that are used for household electric service.	2. Switches a. single pole b. 3-way c. 4-way d. dimmer e. low voltage	List the switches found in your home and at school.	Discuss switches and receptacles and their uses.	(#36),pp. 168 & 176 (#24),pp. 242-245
	3. Receptacles a. duplex b. dual voltage c. air condition d. range e. dryer	Discuss receptacle types and where they are used.		(#36),pp. 183-187
			*Use charts, overhead projectors, and transparencies.	

UNIT V: RESIDENTIAL ELECTRICITY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Identify types of wall plates.	4. Wall plates a. single toggle b. double toggle c. single toggle and duplex receptacles d. weatherproof plates	List advantages of wall plates.		
Understand the use of boxes and their types.	5. Outlet boxes a. handy b. extension c. octagon d. square e. box covers	List ways to use outlet boxes.		
Understand that conduit protects electrical wire.	6. Conduit a. rigid metallic b. nonmetallic c. flexible d. nonmetallic sheathed e. P.V.C. (plastics)	List ways in which conduit protected cable is used indoors and outdoors.		(#24),pp. 196-198
Understand the purpose of the service panel.	7. Service Panel a. weatherhead b. mast c. meter base d. service entry e. grounding system	Discuss the service drop.		(#24),pp. 192-196 (#36),pp. 264-267
Use and be familiar with the National Electric Code.	F. Electric Service Wiring Techniques 1. Rough in 2. Branch circuit wiring 3. Hanging electrical fixtures	Trace electricity from the distribution panel through the home by branch circuits. Hook-up selected circuits and check applications using proper techniques.	Demonstrate electrical service from the service panel through branch circuits.	(#36), Unit IV. Chapters 1-15
Understand the role of Underwriters' Laboratories, the importance of of UL approval and NEC.	G. Load Determination 1. Current 2. Circuit 3. Specialty circuits	List the number of light, plugs, dryer, etc. on a circuit.		(#27), Art. 220-19 Art. 220:, Part 13, Chapter 9.
	H. Review Unit for Test	Review unit	Study sheet or questions	
	I. Test on Unit	Test Review test	Administer test. Review test.	

UNIT VI: DIRECT CURRENT CIRCUITS

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is designed to present to the student direct current circuit analysis techniques. Also included is a study of capacitors in direct current circuits.	The goal of this unit is to introduce basic and advanced techniques of circuit analysis involving resistance and capacitance.	Upon completion of this unit the student will be able to: 1. Determine the equivalent resistance of series, parallel, and series-parallel circuits. 2. Determine branch currents and load resistor voltage drops in series, parallel and series-parallel circuits. 3. State Kirchoff's Laws and use in circuit analysis. 4. Build practical circuits in order to test and confirm these laws. 5. Be able to use varied and advanced circuit analysis techniques. 6. Name several types of capacitors, how they are constructed and analyze DC circuits containing them. 7. Student must pass unit test with 70 percent or better.

VI: DIRECT CURRENT CIRCUITS 22 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will indicate the ability to work Ohm's Law problems.	A. Review Ohm's Law.	Work problems as class.	Review Ohm's Law application. Work problems on board.	(#12),p. 35 (#16),p. 40
Students will be able to define and recognize series circuits.	B. Series Circuit 1. Definition of series circuit 2. Current in series circuit	Have students draw series circuits.	Draw several series circuits on board. Give examples of practical series circuits.	(#12),pp. 53-83 (#16),p. 55
Students will be able to calculate the equivalent resistance of series circuits.	3. Equivalent series resistance	Students calculate total resistance of given circuits.	Demonstrate method for calculating. Construct circuit and use ohmmeter to indicate property of equivalent resistance.	(#12),p. 88 (#16),p. 56
Students will be able to state Kirchoff's Voltage Law and Ohm's Law to calculate missing voltage drops in a series circuit.	4. Voltage drops in series circuits 5. Kirchoff's Voltage Law 6. Polarity of voltage drops	Students work problems involving voltage drops and Kirchoff's Law. Students confirm Kirchoff's Law using lab exercises.	Discuss Kirchoff's laws in lab exercise.	(#12),pp. 89-90 (#16),p. 58
Students will be able to apply principle of voltage division to series circuits.	7. Voltage dividers a. Voltage division b. Loaded voltage dividers	Students work problems involving voltage division. Confirm voltage division using lab exercises.	Demonstrate problems on chalkboard and explain.	(#12),p. 89 (#16),p. 120
Student will be able to calculate power use in series circuit.	8. Power in series circuits a. power used by individual components b. total power used by series circuits	Confirm using lab exercises.		(#16),p. 63 (#12),p. 87
Students will be able to design and construct a working series circuit to specifications.	9. Designing series circuits a. apply the laws to real world b. troubleshooting the circuit	Design and build two and three component series circuits to given specifications.		
Students will be able to define and recognize parallel circuits and list the major characteristics of parallel circuits.	C. Parallel Circuits 1. Definition of parallel circuits 2. Voltage drops on parallel circuits 3. Branches 4. Conductance		Draw simple parallel circuit on board and use to demonstrate principles. Build simple parallel circuit and use to demonstrate principles.	(#16),pp. 76, 83 (#12),p. 95

VI: DIRECT CURRENT CIRCUITS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to determine the equivalent resistance, branch currents, and power use of parallel circuits.	5. Equivalent resistance 6. Branch currents 7. Total current 8. Power in parallel circuits a. total power b. power consumed by individual components	Work problems involving parallel circuits. Confirm laws pertaining to parallel circuits through lab exercise.	Pass out and explain what is expected in lab activity.	(*16), p. 78 (*12), p. 98
Student will be able to: Give Kirchoff's current law	9. Kirchoff's current law			
Design and build a parallel circuit to specifications.		Students will build parallel circuit to specifications.		
Determine the equivalent resistance of series-parallel circuits.	D. Series-Parallel Circuits 1. Equivalent resistance by series and parallel rules on portions of circuit 2. Equivalent resistance by Ohm's Law $R_{eq} = \frac{E_T}{I_T}$	Worksheet on equivalent resistance.	Demonstrate method on several different circuits.	(*16),p. 93 (*12),p. 102
Determine voltage drops, branch currents and power use in series-parallel circuits.	3. Voltage drops on series strings, components, or branches 4. Power use by components	Students will wire a series-parallel exercise to confirm laws.		
Design and build a loaded voltage divider circuit to given specifications.	5. Designing loaded voltage dividers	Design and build circuit to specifications.	Pass out lab activity.	(*16),p. 122
Students will be able to analyze bridge circuits to determine resistance, voltages, or currents.	E. Advanced Analysis Techniques 1. Bridge circuits a. defining bridge circuits b. calculating total resistance c. balanced bridge d. calculating missing resistance in balanced bridge e. calculating voltage drops and currents in bridge circuits	Work problems involving bridge. Analyze methods. Perform lab exercise to confirm laws.	Demonstrate each technique to the class.	

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to: Analyze two-mesh circuits by mesh analysis.	2. Mesh Analysis a. mesh currents b. mesh circuits c. simultaneous equations d. writing mesh equations	Work problems involving mesh analysis techniques.		
Analyze tee circuits and convert Delta to Tee and Tee to Delta.	3. Delta-Tee circuits a. Tee circuits b. Delta circuits c. Delta-Tee conversions d. Tee-Delta conversions	Work analysis problems involving skills of Delta-Tee transformations.		(#16)p, 193
Analyze circuit by loop analysis.	4. Loop analysis a. loop currents b. writing loop equations c. solving for voltage drops d. solving for currents	Work loop analysis problems		
Students will be aware of superposition, Thevenin, and Norton methods of circuit analysis.	5. Other techniques a. superposition b. Thevenin theorem c. Norton's theorem	Students perform each type of analysis.	Illustrate the use of each with simple example problems.	(#16),p. 177
Students will be able to explain capacitor action.	F. Capacitance 1. Dielectric field 2. Electrostatic induction 3. Charging and discharging of capacitors		Demonstrate capacitors ability to store charge.	(#16), p. 420 (#12),p. 228 (#5),p. 52
Explain how the basic capacitor is constructed.	4. Capacitors a. capacitor construction b. dielectric values c. effects of physical construction on value		Dissect several types of capacitors. NOTE: Some oil filled and electrolytic capacitors contain potential hazardous liquids.	
Students will be able to explain the ratings of capacitors and their significance in actual circuits.	5. Capacitor ratings a. capacitance value b. how capacitance determined c. working voltage d. tolerance e. polarity f. capacitor color coding	Work related problems to determine capacitance.		(#16),p.424 (#12),p. 229 (#5),p. 55

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Name several types of capacitors and their general uses.	6. Types of capacitors a. capacitor types b. variable capacitors c. types of dielectrics		Show students different types of capacitors and discuss their characteristics.	
Explain the transient response curves of capacitors, calculate time constants, and explain their importance.	7. Transient response a. transient response--charging b. transient response--discharging.	Build capacitor circuits and measure changing times, graph capacitor voltages, and determine time constants.	Draw transient response on board or overhead projector and discuss charging and discharging.	(#12),p. 238 (#5),p. 151
Determine the total capacitance and working voltage of series and parallel capacitor circuits.	8. Basic capacitor circuits a. total capacitance in series and parallel b. voltage division in series c. voltage ratings in series d. total capacitance in parallel e. voltage ratings in parallel	Build R.C. circuit using series and parallel capacitor connections and measure time constants and voltage distribution.	Discuss fully series and parallel connections and the voltage distribution.	(#12),p. 238
	G. Unit Review			
	H. Unit Test			

UNIT VII: MAGNETISM

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to introduce the student to magnetism. Electric current produces magnetic fields and magnetic fields produce electric current.	To make the student aware of the theories and principles used in dealing with magnetic devices.	Upon completion of this unit the student should be able to: 1. Identify how you get magnets. 2. Understand permeability 3. Understand the term magnetic domain and why the crystals are positioned in a north-south direction.

UNIT VII: MAGNETISM 8 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
At the conclusion of this unit the student should be able to: Classify magnets according to the method by which they obtain their magnetic field.	A. History of Magnetism 1. Magnets 2. Artificial magnets a. shape b. material use c. method used to obtain magnet field	*Note taking Discuss magnetism history. Identify shapes and material used in classifying magnets.	*Lecture and discussion	(#17),Unit 5, pp. 5-7 (#20),p. 56
Demonstrate an understanding of the observed phenomenon of magnetic theory.	B. Magnetic Theory 1. Permeability a. flux b. poles 2. Domain 3. Law of magnetism	Explain what is meant by magnetic flux, permeability, and magnetomotive force.	Show shape of field around magnet using iron filings on white paper.	(#17),Unit 5, pp. 5-13
Name the basic building materials for magnets.	C. Magnetic Materials and Effect 1. Ferromagnetic 2. Diamagnetic 3. Magnetic shielding	Discuss magnetomotive force and reluctance for making a temporary magnet. Discuss places where magnetic shielding is necessary.	Demonstrate the strength of magnetic materials.	(#17),Unit 5,p. 10 (#20), p. 52
Define and understand the terms and formulas used in magnetic circuits.	D. Measuring Magnetism 1. Magnetomotive force 2. Flux density 3. Intensity 4. Reluctance 5. Permeability 6. Retentivity	Identify way to measure magnets.	Lecture	(#20),pp. 56, 57
Develop a working knowledge of electromagnetic relation to electricity.	E. Electromagnetic Effect 1. Relation to current 2. Magnetism in coil of wire 3. Electromagnetic devices a. solenoid b. relay c. circuit breakers d. speakers e. meters f. recording tape	State the principle of electromagnetic induction. Demonstrate a practical circuit using the relay and reed switch.	Use compass to indicate magnetic field around wire. Discuss the operation of several electromagnetic devices, including solenoids and doorbells.	(#17),Unit 5,p. 56 (#20),p. 59 (#17),Unit 5,p. 62
		*In notebook	Use charts, overhead projector, and transparencies.	

UNIT VII: MAGNETISM (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Define induction, inductance, and counter EMF.	F. Inductance 1. Induced EMF 2. Lenz's Law 3. Measuring inductance 4. Effect of cores 5. Quality of coils 6. Transient response 7. Time constants 8. Inductance in series 9. Inductance in parallel	List the unit of inductance. Describe the factors which determine inductance. Draw the schematic symbols for inductor.	Demonstrate inductive kick by using large inductor and neon bulb. Switch low voltage DC on and off to flash neon bulb.	(#17),Unit 8, pp. 6-8 (#17),Unit 8, pp. 9-11
Describe the factors which determine inductance.		Construct RL circuit and determine changing rates and time constants experimentally.		
	F. Test Review			
	H. Test	Test		
		Review test	Review test	

UNIT VIII: TEST EQUIPMENT

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is intended to familiarize students with the more common test equipment and its proper use. Teachers should be aware of the importance of using the correct nomenclature, as well as the need for thoroughness in initial demonstrations.	Students will be given maximum opportunity to identify, select, and handle a variety of electronic test equipment.	Upon completion of this unit the learner will be able to name the various types of test equipment and describe the use of each by completing the unit test. Learner must score at least 70 percent to pass. Demonstrate an understanding of meter construction and oscilloscope fundamentals.

UNIT VIII: TEST EQUIPMENT 8 Hour

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner will be able to read, calibrate, and measure electrical quantities using the analog or digital volt, amp, and ohmmeters.	A. Test Equipment 1. Meter movement analog a. d'Aronval movement 1. construction 2. operation b. taut-band movement c. iron vane 1. radial vane 2. concentric vane d. thermocouple 1. operation 2. construction 3. electrical characteristics	Read chapter. Answer review questions. Take notes. Do lab on familiarization of analog meters.	Lecture Show students proper techniques and safety in using this type of meter.	(#19),pp. 1-5 to 1-20
	2. Ammeter a. computing shunt resistance to increase the range of the ammeter b. scales 1. linear 2. nonlinear c. ammeter accuracy d. circuit connections	Read section on ammeter. Answer programmed review questions. Do lab activity to demonstrate a method of finding the resistance of a meter movement or the ammeter section of a multimeter	Demonstrate possible applications of ammeters. Generate possible quiz or definition sheet.	(#19),pp. 1-21 to 1-34
	3. Voltmeter a. extending the range 1. calculating the multiplier 2. multi-range voltmeters b. loading effect of voltmeters c. typical connections d. typical voltmeters AC & DC e. scales 1. DC 2. AC	Read chapter on voltmeter. Answer programmed review questions.	Demonstrate proper use in hooking up meter in parallel.	(#19),pp. 1-35 to 1-49.

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	4. Ohmmeter a. scale calibration b. creating higher and lower ranges c. shunt ohmmeter d. measurements e. scales	Read section on ohmmeters. Answer programmed review questions. Do lab activity which requires the reading of different resistances.	Demonstrate proper use in reading ranges and scales of the ohmmeter.	(#23),pp. 1-50 to 1-63
	5. Volt-Ohm-Millimeter a. VOM b. DC voltmeter c. millimeter	Read section on VOM. Answer programmed review questions. Do lab activity that involves each section of the volt-ohm-millimeter.	Explain the range switching sockets and ohm control.	(#23),pp. 1-64 to 1-73
	6. Digital/LED or LCD type a. analog to digital conversion b. integrating techniques (1) single-slope A/D conversion (2) dual-slope integration (3) voltage to frequency (4) charge balance c. non-integrating techniques (1) linear-ramp conversion d. signal processor e. displays	Read selected materials on digital meters. Complete programmed review questions Complete a lab activity which demonstrates learner's comprehension of meter.	Demonstrate the operation, function, and reading of the meter.	(#23),pp. 2-6 to 2-28
The learner will be able to identify the components, features, controls, and measure using the oscilloscope. They will also learn to: avoid damage to the scope, properly adjust and calibrate the scope, and connect the scope with minimal disturbance to the quantity being observed.	B. Oscilloscope 1. Cathode ray tube 2. Deflection circuits 3. Oscilloscope circuits 4. Special features 5. Controls	Read section(s) covering oscilloscopes. Take notes. Answer programmed review questions. Display wave forms using scope.	Demonstrate the proper handling, use, and operation.	(#23),pp. 1-50 to 1-63 (#30),pp. 2-15

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Display a wave form (or a selected portion thereof) and measure its characteristics (amplitude, period, frequency). Determine the relationship between two waveforms such as phase shift. Display x-y plots (lissajous fixtures). Interpret the results of oscilloscope measurements taking the limitations of the scope into account.				
The learner will be able to use and identify the waveforms of functional and signal generators.	C. Function/Signal Generator 1. Basic concepts 2. Waveforms a. sine wave b. square wave c. triangle wave d. sawtooth wave e. pulse 3. Radio frequency	Read section covering function/ signal generator. Take notes. Answer programmed review questions. Complete lab activity to demonstrate how the output frequency and voltage can be checked.	Demonstrate use and operation of a function generator.	(#19), pp. 5-111 to 5-125
The learner will be able to develop a working knowledge of the use and function of a transistor tester. The learner will be able to identify the type of transistor and transistor leads using a transistor tester.	D. Transistor Tester 1. beta 2. leakage 3. fet tests	Be able to use this piece of test equipment (if lab equipped). Read chapter. Take notes Complete programmed review questions. Select a couple of different transistors and test each.	Demonstrate/explain purpose and use. Demonstrate proper set-up and use of transistor tester.	(#19),pp. 5-69 (#19),pp. 6-12 to 6-19
	E. Unit Review			
	F. Unit Exam			

UNIT IX. A.C. CIRCUITS

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is designed to present to the student alternating current circuit analysis techniques. Also included is a study of alternating current fundamentals and transformers.	The goal of this unit is to introduce vector analysis techniques for alternating current circuits that contain resistors, capacitors, and inductors.	Upon completion of this unit the student will be able to: Identify specific quantity measurements of AC, waveforms and convert from one to another where appropriate. Analyze RL, RC, and RLC circuits for reactance, impedance, phase angle, true power, and power factor. Determine the resonant frequency and frequency response curves of RLC circuits. Build various types of filter circuits to specific requirements. Explain the operation and applications of transformers.

UNIT IX: A.C. CIRCUITS 17 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to identify basic waveforms by their shape.	A. Alternating Current Fundamentals 1. Waveforms a. sine wave b. square wave c. ramp (sawtooth) wave d. triangle wave	Students take notes in notebook.	Display example waves on oscilloscope or draw on board.	(#12),p. 147 (#16),pp. 314,329
Student will be able to define alternating current quantities and convert measurements where appropriate.	2. A.C. Quantities a. frequency b. period c. wavelength d. peak value e. peak-to-peak value f. effective (RMS) g. average value h. instantaneous value i. harmonious		Draw waveform and show what each quantity represents. Have students convert from one quantity to another. Example: Find wavelength of 1 MHZ signal. Demonstrate changing of one quantity to another.	(#16),pp. 317-322 (#12),pp. 148-151
Students will be able to sketch three phase alternating current waveforms and give application and advantages of polyphase circuits.	3. Polyphase A.C. a. two-phase waveform b. three-phase waveform c. uses of polyphase current d. advantages of polyphase current e. polyphase distribution systems	Discuss advantage of polyphase over single phase A.C.	Draw waveforms on board or use overhead transparencies to indicate phase relationship.	(#12),p. 157 (#16),p. 345
Student will be able to define the terms in-phase and out-of-phase as they relate to alternating currents.	4. Phase relationship a. in-phase voltage and currents b. out-of-phase voltage and currents c. power in A.C. circuits that are in-phase d. power in A.C. circuits that are out-of-phase		Draw out-of-phase signals (voltage and current) and discuss areas of positive and negative power.	(#12),p. 168 (#16),p. 323 (#10),p. 72

UNIT IX: A.C. CIRCUITS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to define and calculate capacitive reactance for a given circuit.	B. Capacitive Circuits 1. Capacitors in A.C. a. capacitive reactance b. phase shift c. power consumption by capacitor	Students graph capacitive reactance versus frequency.	Discuss reactance and how it is determined.	(#16),p. 500 (#12),p. 239 (#10),p. 95
Student will be able to analyze circuits involving resistance and capacitive reactance.	2. Capacitance quantities a. reactance b. impedance c. phase angle d. apparent power e. true power	Build R.C. circuits, applying a variety of frequencies. Measure voltage drops and use oscilloscope display phase relationship between capacitor and resistor.		
	f. power factor g. vector analysis techniques	Analyze R.C. circuits.	Demonstrate process of A.C. circuit analysis using vectors.	
Student will be able to define and calculate inductive reactance for a given circuit.	C. Inductive Circuits 1. Inductive reactance 2. Phase shift 3. Power consumption by inductor	Students graph inductive reactance versus frequency.	Discuss reactance in R.L. circuits and how it is determined.	(#10), p. 100 (#12), p. 191 (#5), p. 138 (#16),p. 499
Students will be able to analyze numerically and vectorally circuits involving resistance and inductive reactance.	4. Inductance quantities a. reactance b. impedance c. apparent power d. true power e. power factor f. vector analysis of R.L. circuits	Build R.L. circuits applying a variety of frequencies, measure voltage drops and display phase relation between inductor and resistor.	Demonstrate application of A.C. analysis to R.L. circuits	
Students will be able to explain the basic operating principles of the transformer. Students will be able to explain the basic physical construction of transformers.	D. Transformers 1. Mutual inductance 2. Coupling 3. Transformer construction a. primary b. secondary c. cores	Using coils and cores indicate effect of coupling of coils.	Show actual transformers to class.	(#12), p. 360 (#12),p. 205 (#5),p. 106 (#10),p. 92

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UNIT IX: A.C. CIRCUITS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to use turns ratio to analyze transformer circuits.	4. Ratios a. turns ratio b. voltage ratio c. current ratio	Solve problem using turns ratio of transformer.	Discuss turns ratio and demonstrate solving problems by turns ratio.	(#12), p. 205 (#16),P. 361 (#5),p. 108
Students will be able to explain how multiple voltage transformers function.	5. Multi-voltage transformers a. tapped secondaries b. tapped primary c. multiple secondaries d. multiple primaries e. variable taps f. auto transformers	Discuss how taps split voltage.	Show tapped transformers	
Students will be able to give several uses of transformers.	6. Transformer uses a. voltage transformation b. isolation c. impedance matching d. signal splitting/inversion e. coupling			(#12), p. 212 (#16,p. 365 (#5),p. 113
Students will be able to name the losses of power in a transformer and methods of minimizing power losses.	7. Power losses/cure a. coil resistance/overwinding b. eddy currents/laminating c. hysteresis/special alloys			(#12),p. 206 (#10),p. 366
Students will be able to define and calculate resonant frequency of an LC circuit.	E. Tuned Circuits 1. Resonance	Students calculate-then experimentally determine resonant frequency of circuit.	Demonstrate determining resonance.	(#12),p. 271 (#5),p. 541
Students will be able to analyze RLC circuits and graph the frequency response curves.	2. Series tuned circuit a. impedance b. frequency response c. apparent power d. power factor e. phase angle f. voltage drops g. line currents h. flywheel effect i. figure of merit--Q j. bandwidth	Student build series RLC circuit and examine voltage drops and currents at frequencies above, near and below resonant frequency. Perform A.C. analysis of RLC series circuit.	Discuss performance of circuit above, below, and near resonance. Demonstrate analysis techniques.	(#12),p. 267 (#10),p. 109

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OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	3. Parallel tuned circuits a. impedance b. frequency response c. apparent power d. power factor e. phase angle f. voltage drops g. line currents	Students build parallel RLC circuit and examine voltage drops and currents at frequencies above, near and below resonant frequency.	Discuss performance of circuit above, below, and near resonance. Demonstrate analysis techniques.	(#12),p. 269 (#10),p. 111
	h. figure of merit—Q i. bandwidth j. flywheel effect	Perform A.C. analysis of RLC parallel circuit.		
Students will be able to draw the four major filters, explain how each works and sketch the basic frequency response of each.	4. Filters a. high pass b. low pass c. band pass d. band reject	Students construct passive filters and determine the frequency responses.	Draw graph of the response curves.	(#10),p. 265 (#12),p. 279 (#16),p. 571 (#5),p. 173
	5. Combination filters a. notch filters b. crossovers c. bypass capacitor filter		Discuss uses of filters.	
	F. Unit Review			
	G. Unit Test			

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UNIT X. SEMICONDUCTOR FUNDAMENTALS

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is to familiarize the learners with the type of semiconductor materials, applications, and theory of operation.	Students will be given maximum opportunity to identify and select semiconductor materials.	Upon completion of this unit, the learner will be able to name the various types of semiconductor materials and their applications by scoring at least 70 percent to pass.

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UNIT X: SEMICONDUCTOR FUNDAMENTALS 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner will be able to understand the importance, advantages and disadvantages of semiconductors	A. Semiconductor Materials 1. Pure semiconductors a. carbon b. germanium c. silicon 2. Low temperature characteristics 3. High temperature characteristics	Read section covering semiconductor materials through high temperature characteristics. Take notes.	Lecture	(#21),pp. 1-10 - 1-20
	4. Doping semiconductors 5. N-type materials 6. P-type material 7. Current in semiconductance	Understand what takes place with doping. Be able to distinguish the difference between N-type and P-type.		(#21),pp. 1-20 to 1-23
	B. P-N Junction 1. Forming junction 2. Depletion region 3. Barrier potential 4. Forward biased 5. Reverse biased 6. Avalanche breakdown 7. Charge carrier recombination	Read material covering this section Take notes.		(#21),pp. 2-5 to 2-13
	C. Unit Review			
	D. Unit Exam			

UNIT XI: ELECTRONIC DEVICES

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is designed to familiarize the student in semiconductor devices and typical circuit applications. The emphasis should be placed upon typical applications and actual circuit operation rather than the process of circuit design. As this area is ever changing the teacher is encouraged to add material whenever it is appropriate.	The goal of this unit is to present to the student the area of semiconductor devices and their applications.	Upon the completion of this unit the student will be able to: Name several types of diodes, explain their operation and state a typical use of each. Construct circuits using diodes such as power supplies and voltage multipliers. Explain the operation of diode circuits. Name two types of bipolar transistors and explain the operating theory of each. Name three types of field effect transistors and explain the operating theory of each. Name four different circuit types and the basic characteristics of each. Explain the operating parameters of transistor circuits. Construct basic small signal amplifier from given circuit diagram. Name several biasing and stabilizing methods for transistor amplifiers. Name three thyristor devices, explain their operation and give applications for each. Construct thyristor circuits to specifications. Demonstrate an understanding of device rating and physical packaging designs. Briefly explain fabrication of integrated circuits.

UNIT XI: ELECTRONIC DEVICES (Continued

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
		Construct simple circuits using I.C.'s to specifications. Name several uses of I.C.'s. Name several uses of operational amplifiers. Construct op-amp circuits to specifications. Name several opto-electrical devices and applications of each.

UNIT XI: ELECTRONIC DEVICES 20 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to explain the operating characteristics of the diode.	A. Diodes 1. Characteristics of diode a. reverse bias b. leakage c. breakdown voltage d. forward bias e. turn on voltage f. forward bias current g. dynamic resistance h. characteristic curve i. testing diodes--ohmmeter j. recombination of carriers	Construct circuit using diode and measure voltage drops and current in forward bias, reverse bias, and with AC applied. Students use ohmmeter to test diodes.	Display characteristic curve on curve tracer if available.	(#31),p. 18 (#14),p. 178 (#10),p. 210 (#16),p. 630
Name several types of diodes and their normal applications.	2. Types of diodes a. rectifier b. switching c. zener d. light emitting diode e. crystal diode f. selenium diode g. schematic symbols	Construct series circuit with resistor and zener diode and examine the operation characteristics.	Use curve tracer to display characteristic curve of each type.	(#6),pp. 179,192 (#31),p. 23.
Explain the different ratings for a diode and identify leads on actual diodes.	3. Ratings a. peak inverse voltage b. forward bias current c. zener voltage d. power dissipation 4. Cathode markings		Show actual diodes and markings--use manufacturers data sheets as source of rating information.	
Students will be able to sketch, construct, and explain the operation of several different diode circuits.	5. Rectifier circuits a. half-wave rectifier b. full-wave rectifier c. bridge rectifier d. diode clipper e. diode clamper	Construct rectifier circuits; display outputs on oscilloscope.		(#31),p. 31 (#4),p. 298

UNIT XI: ELECTRONIC DEVICES (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	6. Diode packaging			
Student will be able to name several methods of filtering and regulating D.C. power supplies.	7. Filtering a. capacitor b. R-C filter c. L-C filter 8. Regulation a. bleeder resistor b. Zener diode c. I.C. regulations d. transistor regulator	Connect different filter circuits to rectifier network--observe effect on output waveform. Add Zener regulator to filtered power supply. Add I.C. regulator to filtered power supply.	Indicate process of determining percent ripple--discuss method of eliminating ripple.	(#5),p. 181 (#31),p. 37 (#4),p. 486 (#10),p. 293 (#31),p. 43 (#4),p. 491 (#5),p. 186 (#10),p. 295
Explain the operation of the voltage doubler as an example of the voltage multiplier.	9. Voltage multiplier a. half-wave doubler b. full-wave doubler c. triplers d. use of multipliers	Construct voltage doublers. Measure inputs, outputs and display waveform.		(#31),p. 41 (#5),p. 184 (#4),p. 490
Name and briefly explain the principles of voltage converters.	10. Voltage converters a. DC to AC inverters b. DC to DC converters		Discuss DC voltage conversion methods and uses.	(#5),p. 254 (#4),p. 501
Student will be able to explain the construction and basic operating theory of the bipolar junction transistors.	B. Transistors 1. Bipolar transistors a. regions b. doping levels c. lead currents d. biasing junctions e. back injection f. current gain 2. Types of bipolar transistors a. NPN b. PNP 3. Fabrications techniques a. regions b. grown junction c. alloy junction d. epitaxial base		Draw simplified diagram on board to aid in explanation. Use overhead or board to show how produced. Show several types of case styles.	(#31),p. 55 (#5),p. 195 (#10),p. 218

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Name and draw diagram on the three basic transistor circuits.	4. Transistor circuits a. common base b. common collector c. common emitter		Draw circuit configurations on board. Give example of where each is used.	
Students will be able to read listing of transistor operating parameters, interpret the information and apply information to actual circuits.	5. Operating parameters a. current gain b. voltage gain c. collector to emitter voltage d. collector current e. base current f. family of curves g. constant power curve h. power dissipation	Construct and test individual transistor circuits for gain. Read manufacturers data sheets and interpret.	Discuss use of data in designing circuits. Discuss sources of this data.	(#10),p. 220 (#31),p. 60
	6. Transistor data a. material codes b. function codes c. case styles d. transistor number			(#31),p. 64 (#8),p. 98
Student will be able to define cut-off and saturation as they apply to transistors.	7. Operating ranges a. cut-off b. linear region c. saturation			
Student will be able to test transistor to determine if it is good with transistor tester or ohmmeter.	8. Transistor testing a. ohmmeter b. transistor testers c. curve tracers	Use each method to separate good and bad transistors.	Demonstrate the use of each to entire class.	(#31),p. 67 (#8),p. 102
Student will be able to define gain of an amplifier.	C. Transistor Amplifier Circuits 1. Gain a. voltage gain b. current gain c. power gain d. decibel			(#31),p. 77 (#5).p. 210 (#16),p. 639
Students will be able to build from a schematic basic amplifier circuits and test each for gain and phase relationship.	2. Amplifier circuits a. common base b. common collector c. common emitter d. common source	Build and test basic amplifier circuits.		

UNIT XI: ELECTRONIC DEVICES (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to define biasing and use load lines on characteristic curves to determine biasing network.	3. Biasing method a. load lines b. quiescent point c. feedback method d. voltage divider method e. bias stabilization method	Use characteristic curves and load line to determine operating range.		(#31),p. 85 (#5),p. 212 (#16),p. 651
Name methods of coupling multi-stage amplifiers, the advantages and disadvantages of each.	4. Coupling methods a. capacitor b. transformer c. direct d. Parlington pair transistors	Discuss which would be best method under various conditions such as small signal, audio work, high frequency, signal splitting, etc.	Use class discussion.	(#31),p. 97
	5. Feedback			
	6. Distortion			(#31),p. 115
Students will be able to name the classes of amplifiers and give the approximate biasing points and uses of each.	7. Amplifier classes a. class A b. class B c. class AB d. class C		Discuss uses of each class.	
Briefly explain the use of the transistor as a switch or indicator/relay driver.	8. Switching and driver circuits a. single transistor--common emitter drivers b. darlington drivers c. switching speeds d. emitter follower drivers and switches	Construct transistor relay or lamp driver circuits.		
Students will be able to explain the construction of the silicon-controlled rectifier and its operation in a circuit.	D. Thyristors 1. Silicon-controlled rectifier a. construction b. terminals c. symbol d. volt-ampere characteristics e. circuit connection f. DC operation g. AC operation h. testing with ohmmeter i. ratings	Construct S.C.R. controlled power supply or SCR light dimmer circuit. Test response of SCR in circuit.	Draw construction on board. Show actual SCR's. Draw volt-ampere characteristics on board or use curve tracer.	(#5),p. 191 (#31),p. 237 (#8),p. 232 (#4),p. 258

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to name applications of the silicon-controlled rectifiers.	2. SCR applications a. switching b. wave shaping			
Explain the construction of the TRIAC and its operation in the circuit.	3. TRIAC a. construction b. terminals c. symbols d. volt-ampere characteristics e. circuit connection f. operation in circuit g. TRIAC applications h. ratings	Construct TRIAC controlled light dimmer/motor speed control.	Draw construction of TRIAC on board. Show actual TRIAC's. Draw volt-ampere characteristics on board or use curve tracer.	(#8),p. 239 (#31),p. 241 (#4),p. 261
	4. DIAC a. construction b. terminals c. symbol d. volt-ampere characteristics e. circuit connection f. operation in circuit g. applications h. ratings	Construct DIAC control circuit.	Draw DIAC construction on board. Show actual DIAC's to class. Draw DIAC volt-ampere characteristics on board or use curve tracer to display.	(#8),p. 242 (#4),p. 261 (#31),p. 244
Explain the construction of the unijunction transistor and its operation in the circuit.	5. Unijunction transistors a. construction b. terminals c. symbols d. volt-ampere characteristics e. circuit connection f. operation in circuit g. application h. ratings	Construct unijunction relaxation oscillator circuit to examine operating characteristics.	Draw unijunction construction on board. Draw unijunction operating characteristics on board or use curve tracer to display.	(#8),p. 245 (#4),p. 265 (#31),p. 72

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OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to briefly describe the fabrication of integrated circuits.	E. Integrated Circuits 1. Fabrication of circuits a. photo lithography b. preparing silicon disc c. fabricating diodes and transistors d. fabrication of resistor e. fabrication of capacitors f. probe testing g. packaging		Develop handout on fabrication techniques.	(#31),p. 215 (#4),p. 271 (#5),p. 357
	2. Integration types a. monolith I.C. b. thinfilm c. hybrid I.C. d. thick film e. moderate scale integration f. large scale integration g. MOS and TTL characteristics		Discuss integration levels as a function of semiconductor technology--point out historical references.	
	3. Package styles a. flat pack b. dual in-line-DIP c. TO style d. pin determination		Show students package styles with example I.C.'s.	
Student will be able to use manufacturers data to properly connect I.C. in a circuit.	4. I.C. circuit construction a. pin numbering b. supply voltage c. ground pins d. unused pins e. I.C. sockets		Give handout to students indicating pin numbering system supply voltage and special handling considerations of different I.C.'s.	

UNIT XI: ELECTRONIC DEVICES (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to name several applications of integrated circuits.	5. Analog I.C.'s a. amplifier b. oscillator c. timers d. voltage regulators e. phase-lock loops 6. Digital I.C.'s a. flip-flops b. logic gates c. microprocessors 7. Systems using I.C. a. automotive electronics b. industrial electronics c. aircraft electronics d. communication electronics e. medical electronics f. personal electronics g. entertainment electronics	Students build I.C. controlled square-wave generator. Students build I.C. L.E.D. flasher.		(#31),p. 135 (#10),p. 275
Students will be able to construct amplifier circuit using operational amplifiers.	8. Operational-amplifiers a. differential amplifier b. split power supplies c. operating characteristics d. circuit connections e. operational-amplifier applications f. summing and integrating amplifiers	Build or test differential amplifier circuit. Build amplifier circuits using op-amps. Build active filter circuit using op-amps. Heathkit #8 -(Electronics circuits.)		Heath: Electronics Circuits, Exp. #6 or similar Heath: Electronics Circuits, Exp. 8 or similar.
Students will be able to explain the operation of the thermistor and name some uses.	F. Thermistors 1. Negative temperature coefficient 2. Positive temperature characteristics 3. Construction styles 4. Operation 5. Applications		Use curve tracer to display volt-ampere characteristics of thermistors.	(#10),p. 395 (#4),p. 239 (#5),p. 49 (#12),p. 70

UNIT XI: ELECTRONIC DEVICES (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to name several types of optoelectric devices, explain briefly their operation, and give application of each.	G. Optoelectric Devices 1. Definition 2. General uses a. isolation of circuits b. communication c. safety d. counting and reading e. light level controls f. lower distortion 3. Light-activated silicon controlled rectifier 4. opto-isolators 5. infra-red LED 6. photo resistors 7. photo diodes 8. LED 9. laser H. Unit Review I. Unit Test			(#10),p. 426 (#4),p. 263 (#31),p. 245

UNIT XII: CIRCUIT FABRICATION

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to provide students with a working knowledge of fabrication techniques and in the process of making printed circuit boards and other type circuit construction.	The student should be able to identify and select the processes and materials in making a printed circuit board.	Upon completion of this unit the learner will be able to demonstrate knowledge of the processes, techniques, and safety practices used in making printed circuit boards, by scoring at least 70 percent on unit test to pass.

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UNIT XII: CIRCUIT FABRICATION 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Upon completion of this unit the learner will be able to list the processes, techniques, and safety practices used in the making of a printed circuit board.				
The learner will be able to understand electronic components and their symbols in electronic schematic diagrams.	A. Schematic Diagrams 1. Understanding electrical and electronic symbols 2. Identify symbols 3. Breadboarding	Set up a simple circuit on a breadboard and be able to complete the following: Trace a signal flow through the circuit. The connection dots in the schematic do not necessarily coincide with tie-points in a pictorial. The schematic is drawn with straight connecting lines either horizontal or vertical. Note: They bear little resemblance in location to the wires in the actual circuit. The schematic usually "proceeds" from left to right following the current flow. The schematic identifies each component by a letter and number, such as R_1, R_2, C_1, and so on, for reference purposes. Values of the components are shown on the schematic, but no other labeling is used.	Pass out sheet(s) with schematic components and supplies.	(#7),p.p. 11-14

UNIT XII: CIRCUIT FABRICATION (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner should be able to identify the materials involved in a PC board.	B. Printed Circuit Boards 1. Materials a. copper electroplating b. gold plating c. tin-lead plating d. tin-nickel plating	List and describe each of the different types of circuit boards.	Display different types of PC Boards.	(#14),pp. 5-20 to 5-22
The learner will be able to clean a PC board.	2. Printing a. PC board cleaning: industry related cleaning procedures (1) chemical cleaning (2) degreasing (3) acid dipping	Given a PC board the student will be able to go through the proper steps in cleaning it.	Demonstrate steps involved in cleaning a PC board.	(#20), pp. 1-38
			Lecture on the ways industry mass produces this process.	(#14),pp. 4-8 to 4-10
The learner will be able to use one of the following circuit pattern transfer methods. (Note: limited only by equipment available in the lab.)	b. photoresists (1) negative acting (2) positive acting c. silk screen printing (1) screen preparation (2) screen inks (3) problems d. contact print e. rub-off transfer f. etch resistant inks 3. Etching a. etching solutions (1) cupric chloride (2) ammonium persulfate (3) ferric chloride	If facilities exist print these two types of boards.	Demonstrate both types of processes.	(#14),pp. 4-15 to 4-22 (#14),pp. 1-25 to 4-33
Learner should be able to set up and etch circuit board.	b. equipment and techniques (1) plastic and glass trays (2) plastic utensils for stirring (3) rock the tray to agitate solution			

UNIT XII: CIRCUIT FABRICATION (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Learner should be able to pass safety test with no less than 100 percent.	c. safety precautions (1) rubber gloves (2) goggles (3) lab coat or apron (4) running water	Be able to list all safety precautions.		
Properly use and set up drilling operations.	4. Drilling a. drill type (carbide or high speed) b. speed c. pressure	Discuss safety using drill and drill sizes.	Give demonstration.	(#20),pp. 5-6
Learner should be able to select and solder proficiently.	C. Soldering 1. Rosin core flux 2. 60/40 ratio (tin to lead mixture) 3. Contact time between board and component 4. Cold solder joints	Discuss and practice making good solder joints.	Give demonstration.	#20,pp. 5-35 to 5-48
Learner should become aware of how and when D and E should be used.	D. Wire Wrapping	Discuss and take notes.	Give demonstration.	
	E. Point-to-Point Wiring	Discuss where and when it might be used.		
	F. Unit Review			
	G. Unit Exam	Take test over unit.		

UNIT XIII: INTRODUCTION TO COMPUTER LITERACY

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to provide the students with a working vocabulary of terms, equipment and processes in the use of a microcomputer.	The goal of this unit is to make the learner knowledgeable and be able to interact with microcomputers.	The learner will be able at the completion of this unit to list components, devices, and terms used in microcomputers. A score of at least 70 percent on the unit test is needed to pass.

UNIT XIII: INTRODUCTION TO COMPUTER LITERACY 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner should be able to understand a block diagram showing how information is processed in a computer.	A. History of Computational Machines B. Processing information 1. Central processing unit (CPU) 2. Random access memory (RAM) 3. Read only memory (ROM)	Read section in book. Take notes. If computers are present in school, take a look inside one.	Lecture Discuss and show students how information is processed using a block diagram and possibly a microcomputer. Show picture of microprocessor.	(#22),pp. 334 to 338 (#29),pp. 33-40
	C. Hardware 1. Main frame a. Bus concept b. Bus system categories 2. Microcomputer 3. Microprocessor			(#22),pp. 10-11 (#29),p.1
The learner should be able to understand the different types of memory storage devices.	4. Storage devices a. cassette b. soft disc c. hard disc d. tape e. card readers		Show student diskettes, punched cards, etc.	(#15),pp. 23-67
The learner will be able to identify accessories, software types and sources.	5. Input/output devices a. types of CRT-video monitors (1) black and white (2) green phosphorous (3) color b. keyboards c. printers (1) dot matrix (2) daisy wheel (3) continuous band/ metal band d. joystick paddles e. modems f. voice synthesizer	Read selected information. Take notes and define each. If school is equipped with such, get some hands-on activity.	Discuss and relate how all devices work and interrelate.	(#11), pp. 27-37 (#15),pp. 16-22

UNIT XIII: INTRODUCTION TO COMPUTER LITERACY (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	D. Software 1. Programming languages a. Basic b. Pascal c. Fortran d. Cobol c. Assembler 2. Programming logic 3. Software sources a. commercial b. user groups c. self-generated			

UNIT XIV: ROBOTICS: AN INTRODUCTION FOR YOUR CLASSROOM

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
The purpose of this unit is to make the student aware of the changes being brought about by automation in industry. Since robotics is in its infancy, there is to date no known textbook covering robotics. Therefore, resources for this unit are made from manufacturers and industrial robotics books.	The student should become aware of cybernetics as it relates to industry and be familiar with the concepts involved in robotics.	The learner will be able to identify the components of a robot, define this robot's work envelope, know different types of robots and their applications, and understand the socio-economic impact of robots upon society. A score of at least 70 percent on the unit exam is necessary to pass.

UNIT XIV: ROBOTICS: AN INTRODUCTION FOR YOUR CLASSROOM 5 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner should be able to define what constitutes a robot and its components.	A. What is Robotics 1. What is a robot 2. Components of a robot a. manipulator/mechanical unit - mechanical linkages and joints (1) pneumatic cylinders (2) hydraulic cylinders/motors (3) electric motors b. controller/brain of robot (1) control the motions of the manipulator (2) store program data in memory (3) interface with the equipment with which the robot interacts c. power source to provide energy for the manipulator's actuators	Read selected material. Take notes. If possible take field trip to a local industry to see robots in action.	If possible have a robotic demonstration in class by a distributor. Discuss and point out components of a robot using either a robot in class, text, visual aids or handouts.	(#34),p. 1 (#9),pp. 19-38
	3. Work envelope a. what it was designed for b. coordinate system where they work (1) jointed arm (2) spherical coordinate (3) cylindrical coordinate configurations	Read selected information. If lab is so equipped, do lab activities. If not list and discuss pros, cons, and limitations.	If possible, use robot visual aid or handout.	(#9),p. 42 (#2),pp. 3-9

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
The learner should be able to list and define the types of robots.	B. Types of Robots 1. Non-servo controlled a. simplest/least expensive b. responds to a predetermined sequence c. has the capacity to respond to changes in manufacturing environment 2. Servo-controlled a. environmentally adaptive b. sense devices (1) position (2) speed (3) load (4) force 3. Remote controlled a. types (1) master-slave unit (2) telemetry control (3) wire control b. application (1) environment where human cannot function (2) where robot travels great distances	Take notes. Define use of each. Discuss limitations and applications of each.	Discuss the different types of robots and where they may be used.	(#9),p. 33
The learner should be able to list and compare robotic applications in industry relating it to lab activities within the classroom.	C. Robotic Application 1. Industrial a. spot welding b. arc welding c. material handling d. assembly e. spray painting	Read, list and discuss robotics in industrial situations.	Introduce industrial applications.	(#34),pp. 3-5

UNIT XIV: ROBOTICS: AN INTRODUCTION FOR YOUR CLASSROOM (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	2. Industrial Arts classroom a. spot welding b. arc welding c. electronic component assembly d. machine loading and unloading e. line production (1) material handling (2) assembly control (3) finishing process (4) quality control (5) research and development (6) metal casting a. pouring b. shake-out c. mold venting (7) other imaginative applications.	Student can become most creative and imaginative if lab is equipped with a robot. Learner can simulate industrial robotic processes.	If possible tie-in the industrial process with automated application to the classroom.	
8. The learner should be able to list and discuss the implications of robotics to the work place.	D. Social Economic Impact 1. What cybernetics means to industry 2. Productivity levels	Discuss future implications.	Encourage students to take a serious look into the past, present and future.	(#9),p. 111 (#2),p. 11

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UNIT XV: INDUSTRIAL ELECTRICITY/ELECTRONICS

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
This unit is designed to present to the student information on the industrial applications of electricity and electronics. The unit includes a study of motors and generators, heating devices and methods, lighting and producing chemical reactions. That portion of the unit on producing chemical reaction may be particularly important to students in the petro-chemical corridor of Louisiana.	The goal of this unit is to familiarize the students with industrial applications of electricity and electronics.	As indicated by a minimum score of 70 percent, upon completion of this unit the student will be able to: Name four types of generators and explain how they operate. Name several types of motors, their uses and starting methods. Read a motor nameplate and gather specific information and apply that information to a specific need. Name several methods of producing heat from electricity and briefly explain each. Explain how different lighting systems operate. Explain the importance of electrochemical reactions in industry and name several important electrochemical processes used.

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UNIT XV: INDUSTRIAL ELECTRICITY/ELECTRONICS 10 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to explain the operating theory of AC generators.	A. Generators 1. Generator action 2. Inducing voltage and currents 3. Generating the AC cycle--single loop 4. Output voltages 5. Moving field alternators	Assemble and test generator demonstrator.	Demonstrate generator effect using magnet or wire coil or telephone generator.	(#12),p. 153 (#16),p. 311 (#5),p. 90
Explain the operating theory of DC generators.	6. DC generator a. brushes, poles, field coils b. commutator action c. pulsing DC d. lowering ripple e. generator construction f. split rings and commutator		Dissect automobile generator and show parts.	(#23),p. 179 (#10),p. 133
Name the four different types of generators and normal application of each.	7. Types of generators a. series generator b. shunt generator c. compound generator d. independently excited e. generator applications		Discuss types.	(#10),p. 136
Students will be able to explain the operating theory of DC motors.	B. Motors 1. DC motors a. motor action b. commutation c. counter EMF d. current draws e. speed f. motor starting	Assemble and test simple motor demonstrator.		(#10),p. 141 (#6),p. 287 (#23),p. 173

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UNIT XV: INDUSTRIAL ELECTRICITY/ELECTRONICS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to explain the operating principles of AC motors.	2. A.C. motors a. rotating the magnetic field b. inducing rotor voltages c. starting the rotation d. motor force e. centrifugal switches	Operate motor demonstrator on A.C.		(#10),p. 150 (#6),p. 290 (#23),p. 176
Name several types of motor and an example of their normal applications.	3. Types of motors a. series DC motor b. compound DC motor c. brushless DC d. split phase AC e. polyphase AC f. synchronous motors g. shaded pole motors h. repulsion inductions i. dual voltage j. linear induction motor	Discuss uses of motors and try to determine type from use.	Give normal or common application for each type named	(#10),p. 150 (#6),p. 292 (#23),p. 176
Student will be able to identify major parts of the motor.	4. Motor construction a. poles (stator) b. housing c. bells d. armature (rotor) e. commutators f. centrifugal switch g. bearings h. fan		Disassemble motor and show parts and how they interact.	
Student will be able to read motor plate or information sheets and interpret information.	5. Motor ratings a. voltage b. current c. horse power d. phase e. cycle f. speed g. temperature rise	Read motor plates and report information.	Discuss motor plates and information found on them.	

UNIT XV: INDUSTRIAL ELECTRICITY/ELECTRONICS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to name several types of motor starting systems and examples of their applications.	6. Motor starting systems a. potentiometers b. stepped resistors c. magnetic starters	Wire magnetic starter to motor or lamp to indicate hook-up.		
Briefly explain procedures for care and maintenance of electric motors.	7. Care and maintenance of motors a. lubrication b. cleaning	Student committee to service motor in lab.	Discuss greasing, cleaning, oiling parts, and thermal overload protection.	
Student will be able to explain resistance heating and name several applications.	C. Resistance Heating 1. Resistance heaters a. radiant b. infrared 2. Welding a. arc welding b. spot welding 3. carbon arc a. furnaces b. lamps c. welding	Wind heating coil of nichrome wire and test.	Use high voltage transformer to indicate heat and light aspects of electric arcs.	(#6),p. 302
Student will be able to name several uses of electricity to produce chemical reactions.	D. Electrochemical Production by Electrolysis 1. Oxygen 2. Hydrogen 3. Chlorine	Produce oxygen and hydrogen by electrolysis of water. Caution: Hydrogen is flammable Students metal plate small objects.	Discuss importance of these processes to industry and society.	(#6),p. 269
Students will be able to explain the different aspects of high frequency heating and give examples of their uses.	E. High Frequency Heating 1. Induction heating 2. Microwave heating 3. Dielectric heating		Use microwave oven as example of high frequency heating.	(#6),p. 306

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OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Students will be able to explain the methods used to produce light.	F. Electric Lighting 1. Incandescent lamps 2. Ionized noble gasses a. neon b. argon c. xenon 3. Ionized metal vapor a. fluorescent b. black light 4. Metal vapor-arc lamps G. Unit Review H. Unit Test	Student use neon bulb to construct relaxation oscillator.	Demonstrate turn-on voltage and current response of glow lamps using neon bulb.	(*6),p. 259 (*12),p. 62

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UNIT XVI: CAREERS

INTRODUCTION (PURPOSE/RATIONALE/INTENTION)	UNIT GOAL(S)	GENERAL UNIT OBJECTIVES
As industrial arts is to aid in vocational selection by the student it is important that the student be provided career information. This unit is designed to provide such information. The teachers should feel free to incorporate this unit at any point in the course that is practical.	The goal of this unit is to familiarize the student with possible career opportunities in the field of Electricity/Electronics.	Upon the completion of this unit the student will be able to use several sources of career information.

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XVI: CAREERS 3 hours

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
Student will be able to name several occupations related to the Electricity/Electronics and state sources of further information on these occupations.	A. Engineering 1. Nature of work 2. Where employed 3. Employment outlook B. Technician 1. Job types a. television b. radio c. communications d. computer 2. Training requirements 3. Training sources C. Utilities 1. Power plant workers 2. Transmission and distribution 3. Consumer services D. Telephone Companies 1. Installers and repair 2. Operators 3. Central office installers 4. Line construction and maintenance E. Manufacturing 1. Managerial 2. Technician a. lab technicians b. draftsmen c. electronics technician 3. Assembly 4. Machining 5. Fabricating 6. Processing 7. Testing	Investigate possible careers of interest.	Bring in resource people from community to speak to class.	

UNIT XVI: CAREERS (Continued)

OBJECTIVES	TOPICS	STUDENT ACTIVITIES	TEACHER ACTIVITIES	RESOURCES
	F. Construction Electrician 1. Industrial 2. Commercial 3. Residential			
	G. Maintenance Electricians			
	H. Broadcasting			
	I. Teacher 1. Secondary 2. Technical school 3. University			
	J. Sources of Information 1. Government agencies 2. Companies 3. Unions		Demonstrate use of occupational outlook handbook and other sources.	

APPENDIX 1

SAMPLE TESTS

Unit I--Electricity/Electronic Safety
Sample Test (Review)

Name:______________________________ Class:_______________ Date:_______________

I. Multiple Choice: For each item below select the one best answer. Then write the letter that represents your choice on the line to the left of each item.

____1. You should wear suitable eye protection

A. to improve your vision
B. to avoid myopia
C. when engaged in any activity where hazards may exist
D. to improve your appearance

____2. Jewelry

A. should never be worn in the electrical/electronics shop
B. should all be removed when working in the shop except rings
C. should be worn to improve your appearance
D. can be worn if the student wishes

____3. What factors determine how much current will flow through the human body?

A. The amount of volts in the line
B. The length of time you are connected
C. The resistance of the body and whether the skin is moist or dry
D. The strength of the person and his/her age

____4. Some typical electrical shock hazards are

A. wearing rubber sole shoes
B. using the wrong extension cord
C. working in low voltage area
D. working around worn insulation

____5. A safe distance for operating around live circuits 3,501 to 11,000 volts is

A. three feet
B. two feet
C. one foot
D. one-half foot

____6. To control fires associated with electrical equipment and facilities, the extinguishing agent must be a nonconductor of electricity and provide a smothering effect. How is this type of fire classified?

A. C
B. D
C. A
D. B

____7. In marking physical hazards, "caution" identification of high voltages at machinery is done by which of the OSHA color codes.

A. Purple
B. Red
C. Green
D. Yellow

Unit I Sample Test (Continued)

____8. What work is done with side-cutting pliers?

A. Use for cutting very soft wire
B. Use for cutting heavier wire
C. Use for forming loops at the end of wires
D. Bending wire lugs

____9. The path to ground is permanent and continuous so that the path has ample current-carrying capacity. This is

A. a live circuit
B. a poor ground
C. a good ground
D. none of these

____10. The ohmmeter should

A. never be connected to a source with power
B. always connected in parallel
C. always connected in series
D. any of the above

Unit I--Electricity/Electronic Safety
Test Key

C 1.

A 2.

C 3.

D 4.

B 5.

A 6.

D 7.

B 8.

C 9.

A 10.

Unit II--Math Review
Sample Test

1. $\frac{1}{10} + \frac{1}{8} + \frac{1}{40} =$ __________

2. $\frac{2}{3} + \frac{6}{7} - \frac{4}{21} =$ __________

3. $\frac{4}{9} + \frac{2}{3} =$ __________

4. $\frac{3}{2} : \frac{1}{4} \cdot \frac{2}{6} =$ __________

5. $2 \cdot \frac{5}{8} \div \frac{3}{4} =$ __________

6. $\frac{6}{13} \div \frac{8}{39} =$ __________

7. $\begin{array}{r} 836 \\ \underline{\times 79} \end{array}$

8. $\begin{array}{r} 6.95 \\ \underline{\times\ 86} \end{array}$

9. $\begin{array}{r} 5.26 \\ \underline{\times 3.5} \end{array}$

10. $2.5\,\overline{)\,53,25}$

11. $16\,\overline{)\,228}$

Express in scientific notation:

12. 186,000 = __________

13. 3,462,000,000 = __________

14. .0000056 = __________

15. .00102 = __________

Express as decimal numbers:

16. $3.26 \times 10^{8} =$ __________

17. $4.71 \times 10^{-8} =$ __________

18. $1.346 \times 10^{6} =$ __________

Make the following conversions as indicated.

19. 34600 = __________ KΩ
20. 3.64 ua = __________ A
21. 11.6 K = __________ Ω
22. 1.43 M = __________ KΩ
23. 150,000,000 = __________ KV

Unit II--Sample Test (Continued)

Solve the following equations for E.

24. $3E = 16$ E = ______________

25. $\frac{E}{5} = 56$ E = ______________

26. $2E = 36 + E$ E = ______________

27. $V = \frac{E\,R}{R + S}$ E = ______________

28. $1.26 \times 10^{3} + 1.4 \times 10^{4} =$ ____________________

29. $\sqrt{625} =$ ____________________

30. $\sqrt{144 \times 10^{-3}} =$ ______________

Unit II--Math Review
Test Key

1. 1/4
2. 4/3
3 10/9
4. 1/8
5. 5/3
6. 9/4
7. 66044
8. 597.70
9. 18.41
10. 21.3
11. 14.25
12. 1.86×10^{5}
13. 3.462×10^{9}
14. 5.6×10^{-6}
15. 1.02×10^{-3}
16. 326,000,000
17. .0000000471
18. 1,346,000
19. 24.6 K
20. .00000364A
21. 11,600 Ω
22. 1,430K Ω
23. 150,000K V
24. # = 5.333
25. # = 280
26. E = 36
27. $E = \frac{V R + VS}{R}$
28. $15.26 \times 10^{3} = 1.526 \times 10^{4}$
29. 25
30. 3.88×10^{-2}

Unit III--Nature of Electricity
Sample Test (Review)

Name:______________________ Class:__________ Date:____________

I. Multiple Choice: For each item below select the one best answer. Then write the letter that represents your choice on the line to the left of each item. Fill in the blank for 16 through 20.

____1. The basic material that makes up all matter is the

A. atom
B. element
C. electron
D. proton

____2. The smallest unit of matter that still retains the structure of the element is

A. proton
B. element
C. neutron
D. atom

____3. An atom that has lost an electron is called

A. positive ion
B. negative ion
C. neutral atom
D. none of these

____4. Particles with like charges will repel each other, particles with unlike charges will attract each other. What law of principle is this?

A. Ohm's Law
B. Electrostatic field
C. Law of electrical charges
D. EMF

____5. The outer part of the nucleus with a negative charge is

A. electron
B. neutron
C. proton
D. atom

____6. Material that has a large number of free electrons is called

A. insulators
B. terminals
C. conductors
D. atoms

Unit III--Sample Test (Continued)

____7. Which is the best conductor for electricity?

A. Copper
B. Aluminum
C. Glass
D. Silver

____8. A material with few free electrons is called a/an

A. insulator
B. terminal
C. conductor
D. proton

____9. Which is not an insulating material?

A. Dry wood
B. Rubber
C. Wire
D. Glass

____10. Capacitors make it possible to store electric energy. Electrons held in store are also known as

A. insulating
B. electrical potential
C. semi-conducting

____11. Holding back or impeding the movement of electrons along a conductor is known as

A. temperature
B. material
C. resistance
D. semi-conductor

____12. The relationship of voltage, current, and resistance to each other is covered by a set of basic electrical principles known as

A. Ohm's Law
B. Kirchoff's Law
C. EMF
D. Law of charges

____13. The equation for voltage (emf) is:

A. $I = \frac{E}{R}$

B. $R = \frac{E}{I}$

C. $E = I \times R$

Unit III--Sample Test (Continued)

____14. The equation for current is:

A. $E = I \times R$

B. $R = \frac{E}{I}$

C. $I = \frac{E}{R}$

____15. The equation for resistance is:

A. $E = I \times R$

B. $R = \frac{E}{I}$

C. $I = \frac{E}{R}$

16. The rate of doing work is called ______________________________.

17. The rate in which weight is moved is ___________________________.

18. Electric power is measured in _________________________________.

19. The basic formula for determining power in watts is ______________________________.

20. There are how many watts in a kilowatt? ____________________________________.

Unit III--Nature of Electricity
Test Key

1. B - Element

2. D - Atom

3. A - Positive ion

4. C - Law of electrical charges

5. A - Electron

6. C - Conductors

7. D - Silver

8. A - Insulator

9. C - Wire

10. B - Electrical Potential

11. C - Resistance

12. A - Ohm's Law

13. C - $E = I \times R$

14. C - $I = \frac{E}{R}$

15. B - $R = \frac{E}{I}$

16 Power

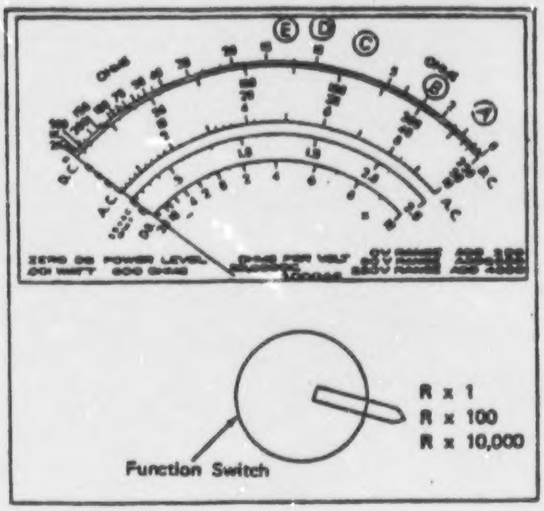
17. Horsepower

18. Watts

19. $P = E \times I$

20. 1000 W

Unit IV—Meters and Measuring
Sample Test



Read and record the resistance on the ohmmeter scale above.

__________1. Function switch in the R X 1 position. Needle is pointing to "B" on the scale.

__________2. Function switch in the R X 10,000 position. Needle is pointing to "C" on the scale.

__________3. Function switch in the R X 100 position. Needle is pointing to "B" on the scale.

__________4. Function switch in the R X 10,000 position. Needle is pointing to "E" on the scale.

__________5. Function switch is in the R X 100 position. Needle is pointing to "E" on the scale.

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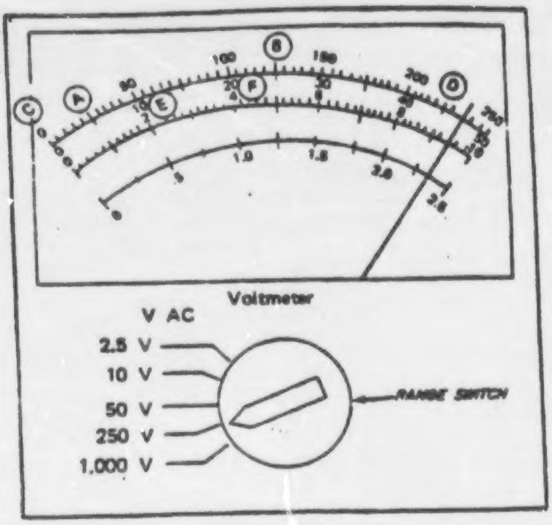

Read and record the voltage of voltmeter.

__________6. Range switch in the 1000V position. Needle is pointing to "F" on the scale.

__________7. Range switch in the 50V position. Needle is pointing to "F" on scale.

__________8. Range switch in the 250V position. Needle is pointing to "D" on the scale.

__________9. Range switch in the 2.5V position. Needle is pointing to "D" on the scale.

__________10. Range switch in the 2.5V position. Needle is pointing to "F" on the scale.

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Unit IV--Meters and Measuring
Test Key

1. 3 ohms
2. 70,000 ohms
3. 300 ohms
4. 130,000 ohms
5. 1,300 ohms
6. 4.5V x 100 = 450V
7. 22.5V
8. 225V
9. 2.25V
10. 1.125V

Unit V--Residential Electricity
Sample Test

Multiple Choice: Select the one best answer and write the letter that represents it on the line to the left of each item.

____1. What is the AC voltage produced at a generating station?

A. 186,000V
B. 4,000V
C. 132,000V
D. 13,200V

____2. What is the voltage at which electricity is delivered to the home?

A. 186,000V
B. 2,300V
C. 240V
D. 13,200V

____3. Once electricity passes the meter, it is hooked up to a

A. branch circuit
B. distribution panel
C. service drop
D. service head

____4. Most laws or regulations covering the wiring of houses are based on

A. Underwriters Laboratories, Inc.
B. Canadian Standards
C. New York Board
D. National Electrical Code

Matching: Match the tools to their common uses by selecting the letter of the tool to match your choice on the line to the left of each item.

A. Lineman's pliers
B. Long nose pliers
C. Adjustable wire strippers
D. Multi-purpose tool
E. Soldering gun (pencil)
F. Ammeter
G. EMT bender
H. Volt ohmmeter
I. Drill motor
J. Fish tape

____5. (a) Forming small conductors (b) holding and pulling on conductors (c) cutting conductors

____6. (a) Stripping insulation from conductors (b) cutting conductors (c) forming conductors

____7. Boring holes for cables or conduits when electricity is available

____8. (a) Checking circuit amperage (b) checking individual load amperage (c) checking motor starting and running current

Unit V--Sample Test (Continued)

____9. (a) Stripping insulation (b) use to crimp terminals (c) cutting small bolts

____10. Bending EMT

____11. (a) Pulling wires or cables through EMT or pipe (b) pull cables up insulated walls

____12. (a) Cutting cables and conductors (b) cutting screws (c) forming large conductors (d) pulling and holding conductors

____13. (a) Splicing conductors (b) splicing soldered conductors

____14. (a) Measuring circuit voltages (b) measuring circuit resistance (c) checking for circuit voltage

True-False: If you believe the statement is true, circle "T". If you believe it is false, circle "F".

T F 15. Single pole switches are used to turn lights on and off in one place.

T F 16. Three-way switches are used to turn lights on and off in two places.

T F 17. Romex cables are available with two or three wires and a bare ground wire.

T F 18. Flexible conduit and rigid conduit is bent with a tool called a conduit bender.

T F 19. Only two large appliances should be on one circuit. Example: range, dryer a dishwasher.

T F 20. Most electrical boxes are nailed to the stud to hold them in place.

Unit V--Residential Electricity
Test Key

1. D - 13,200V
2. C - 240V
3. B - Distribution panel
4. D - National Electrical Code
5. B - Long nose pliers
6. C - Adjustable
7. I - Drill motor
8. F - Ammeter
9. D - Multi-purpose tool
10. G - EMT bender
11. J - Fish tape
12. A - Lineman's pliers
13. E - Soldering gun (pencil)
14. H - Volt ohmmeter
15. True
16. True
17. True
18. False
19. False
20. True

Unit VI--Direct Current Circuits
Sample Test

1. State Kirchoff's Current Law ______________________________

2. State Kirchoff's Voltage Law ______________________________

3. Define dielectric material ______________________________

4. Name 4 types of capacitors-- ____________, ____________, ____________, ____________

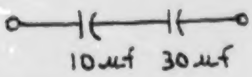
5. .005uf = ____________pf

6. Define working voltage ______________________________

7. Calculate the time constant of an R.C. circuit with a 1.2 uf capacitor and 100KΩ resistor. ______________________________

8. Define series circuit ______________________________

9. Calculate the total capacitance.

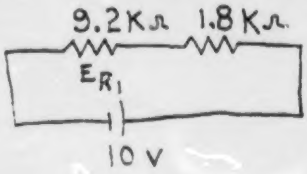


____

10. Give the formula for equivalent resistance in parallel. ______________________________

Solve for each of the indicated quantities.

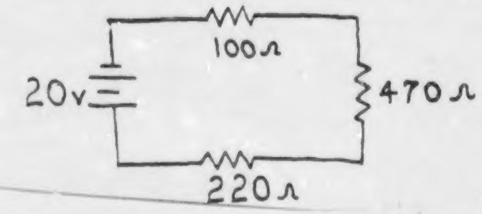
11.



E_{R_1} = ________

R_{Eq} = ________

12.

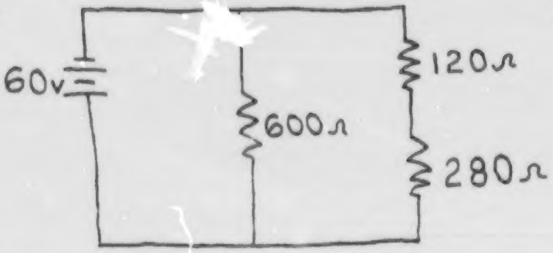


R_{Eq} = ________

I = ________

$P_{470\Omega}$ = ________

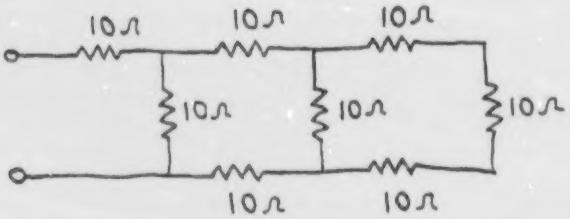
13.



R_{Eq} = ______

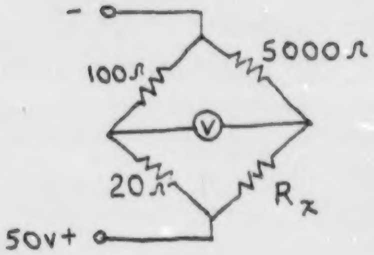
P_T = ______

14.



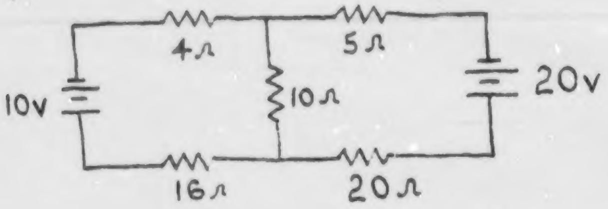
R_{Eq} = ______

15.



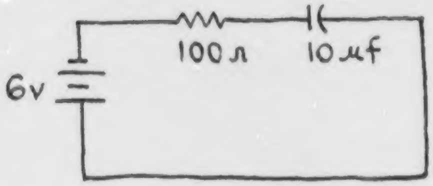
To what is R_X equal if the voltmeter reads 0V?______________

16.



Determine the current through the 1 ohm resistor.__________________

17.



What is the current in the circuit after 10 seconds?_______________

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Unit VI--Direct Current Circuits
Test Key

1. The Algebraic sum of the currents entering a node is zero.
2. The Algebraic sum of the voltages around a loop equals zero.
3. Insulating material
4. Electrolytic, disc, polyester film, wax paper, mica, etc.
5. 5000 pf
6. The maximum safe voltage a capacitor may be charged to.
7. .12 seconds
8. Circuit with only one path
9. 7.5 uf
10. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
11. 8.364V, 11KΩ
12. 790Ω, 25.3 MA, .031 W
13. 240Ω, 10W
14. 17.33 Ω
15. 1000 Ω
16. .368A
17. 0 A

Unit VII--Magnetism
Sample Test

Fill in the blanks:

1. Lodestone is an example of a natural ______________________________.

2. Man-made magnets are referred to as ______________________ magnets.

3. The property that determines a material's magnetic characteristic is called permanence or ___________________________________.

4. Permeability is defined as the ease with which a substance will accept ______________________________ lines.

5. Small groups of these atoms tend to form tiny permanent magnets called ______________________________________.

6. When current flows through a wire; a magnetic _________________________ is developed around the wire.

7. Horseshoe shapes have an advantage over the bar shapes because the ___________ are close together.

Answer the following questions:

8. What determines the polarity of an electromagnet?

9. What two factors determines the strength of a coiled conductor?

10. What kind of magnet results when low-carbon steel is used?

Unit VII--Magnetism
Test Key

1. Magnet
2. Artificial
3. Permeability
4. Flux
5. Magnetic domains
6. Filed
7. Poles
8. The direction of current flow
9. The amount of current flowing in the coil and the number of turns of wire
10. Temporary magnet

Unit VIII--Electronic Test Equipment
Sample Test

1. The permanent magnet moving coil meter is the type used in most general-purpose meters. This type of movement is often called ________________ movement.

   A. taut-band
   B. iron vane
   C. d/Arsonval
   D. Electrodynamometer

2. All voltage measurements are made with the meter in ______________________ with the circuit.

3. The purpose of the zero adjustment on the ohmmeter is to compensate for changes in ________________________ ______________________________.

4. Before a circuit may be tested with an ohmmeter, the _________________________ must be ___________________________________.

5. When the voltmeter, ammeter, and ohmmeter are combined into a single unit, the unit is called a _____________________ or a _________________________.

6. A meter which converts heat to electricity to drive a d'Arsonval movement is called a ________________________________.

7. When converting analog to digital, the single-stop method has better resolution and accuracy than the dual-slope method. True or False

8. To measure larger current values with a digital meter, the resistance in the meter is increased/decreased.

9. What is the most popular type of display used in a digital meter?

   A. d'Arsonval
   B. Liquid crystal display
   C. Electrostatic
   D. Light emitting diode

10. A display which is brighter than the LED but not as bright as the incandescent is the ____________________________________.

11. The liquid crystal display uses more/less power than any other display.

12. A 3-digit meter has a maximum range of

    A. 99V
    B. 999V
    C. 9999V
    D. 99999V

13. The heart of any oscilloscope is the ______________ ______________ ______________.

14. What are the two methods for electron beam deflection in the CRT?

______________________________ and ______________________________

15. Why should the beam keep moving across the CRT screen?

16. The triggering in the oscilloscope helps to ______________________________ the display on the screen.

17. Oscilloscope voltage measurements are:

A. peak-to-peak
B. RMS
C. average
D. AC only.

18. Which of the following statements is true concerning transistor testers?

A. Leakage can be measured in the circuit, while beta must be measured out of the circuit.
B. Beta can be measured in the circuit, while leakage must be measured out of the circuit.
C. Leakage and beta can be measured in the circuit.
D. Neither leakage nor beta can be measured in the circuit.

19. A power supply in an oscilloscope must

A. only produce a number of voltages
B. be able to produce a variety of voltages
C. be well regulated
D. all of the above.

20. A delayed sweep:

A. is used in place of a magnifier
B. is the normal sweep
C. has a separate time base
D. all of the above.

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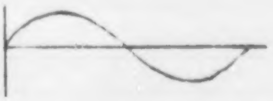
Unit VIII--Electronic Test Equipment
Test Key

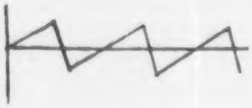
1. C
2. parallel
3. battery voltage
4. power; removed
5. VOM; multimeter
6. thermocouple
7. false
8. decreased
9. LCD
10. gas discharge
11. less
12. B
13. cathode ray tube
14. electromagnetic, electrostatic
15. because the phosphor will burn
16. stabilize
17. A
18. B
19. D
20. D

Unit IX--AC Circuits
Sample Test

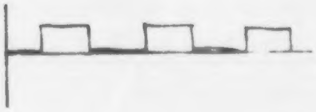
Identify each of the following waveforms



1. ____________________



2. ____________________



3. ____________________

4. If a sine wave has a peak voltage of 12V, what is its RMS value?

   ____

5. What is the period of a 150 KHZ signal? ____________________

6. Why do large motors and heating units use three-phase alternating current?

   ____

7. Opposition to alternating current produced by ideal capacitors or inductors is called ____________________.

8. Impedance is the combined opposition of ____________________ and ____________________ of a circuit.

9. Impedance is measured in ____________________.

10. Three losses of power in a transformer are ____________________, ____________________ and ____________________.

11. A connection to the secondary of a transformer is called a ____________________.

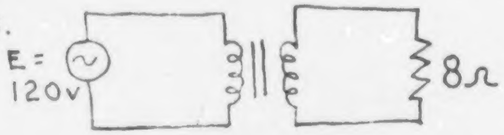
12. Define electrical isolation. ____________________ ____________________.

13. Power factor is the ratio of ____________________ to ____________________ in an ac circuit.

14. Calculate the resonant frequency of a circuit that contains 1.6 mH of inductance and 6.25 pf of capacitance? ____________________

Solve for the indicated quantities:

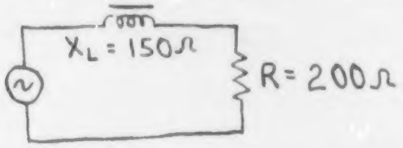
15.



Primary = 100 turns
Secondary = 1250 turns

$I_{Secondary}$ = ____________________
Power into Primary + ____________________

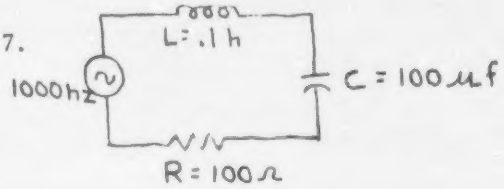
16.



Find: Z = ______________________________

Phase angle = ____________________________

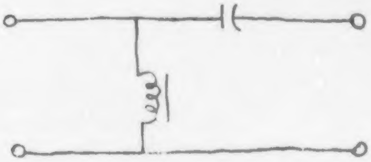
17.



Z = ______________________________

Identify the circuit diagrams below.

18.



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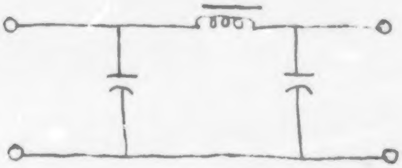
19.



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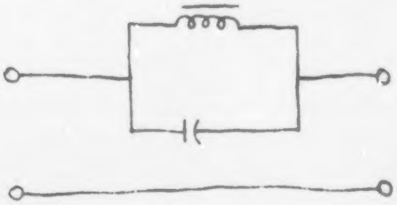
20.



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Unit IX--AC Circuits
Test Key

1. Sine wave
2. sawtooth or ramp wave
3. square wave
4. 8.484
5. 6.67 u seconds
6. constant power
7. reactance
8. resistance, reactance
9. ohms
10. hysterysis, eddy currents, resistance
11. tap
12. physical separation of two circuits.
13. true power, apparent power
14. 1.59 MHZ
15. 187.5 A, 281, 250 W
16. 250Ω , 37°
17. 636 Ω
18. High pass
19. Low pass
20. Band reject

Unit X--Semiconductor Fundamentals
Sample Test

1. Atoms held together within a pure semiconductor are held together
   - A. by positive and negative charges
   - B. in random manner
   - C. by covalent bonds
   - D. like the atoms within a conductor

2. Current flow in a semiconductor consists of
   - A. holes only.
   - B. ions
   - C. electrons only
   - D. electrons and holes

3. Which of the following is not a benefit of semiconductor devices?
   - A. Higher reliability
   - B. Lower cost
   - C. Smaller size, less weight
   - D. Higher operating voltages
   - E. Less power consumption

4. What type of semiconductor material utilizes electrons as majority carriers?
   - A. P-type
   - B. N-type
   - C. Trivalent
   - D. Intrinsic

5. Both germanium and silicon materials are made up of atoms that have four electrons in their outer shell. These electrons are referred to as ____________ electrons.

6. The basic function of a semiconductor device in an electronic circuit is to
   - A. control current or voltage
   - B. replace vacuum tubes
   - C. simplify design

7. When an electron breaks away from a covalent bond, a hole is created. True or False

8. The resistance of a semiconductor________________ as the temperature decreases.

9. A semiconductor at high temperatures will function as a_____________________.

10. The two most used materials in making semiconductor electronic components are ________________________________ and ________________________________.

Unit X--Semiconductor Fundamentals
Test Key

1. C
2. D
3. D
4. B
5. Valance
6. A
7. True
8. Increases
9. Conductor
10. Silicon and germanium

Unit XI--Electronic Devices
Sample Test

1. If a positive voltage is applied to the anode of a diode it is said to be in the ______________________________ condition.

2. The white band marks the ________________________________ of the diode.

3. The three basic bi-polar transistor circuits are _________________________, ______________________________, ______________________________________.

4. Define cutoff. ____
____

5. A thyristor used to control alternating current is called the ____________ ______________________________________.

6. Name three case styles for integrated circuits. _________________________, ______________________________________, _____________________________.

7. A diode that has a controlled avalanche breakdown voltage that can be used as a regulator is the _______ ____________________ diode.

8. Light emitting diodes produce light in the _________________________________ bias condition.

9. The terminals of a field effect transistor are the _________________________, ______________________________________, and _______________________________.

10. A device whose resistance decreases with light intensity is called a ____.

11. A device used to increase voltage without a transformer is called a ____.

12. An increase in the amplitude of a signal is __________________________________.

True-False:

T F 13. Light emitting diodes produce light by getting hot.

T F 14. Integrated circuits are used for digital and analog signals.

T F 15. The bias on a transistor is its operating point.

T F 16. Transistors can be used to operate a relay from a small input signal.

T F 17. The silicon-controlled rectifier is a bi-directional device.

T F 18. A full wave bridge rectifier can be packaged as a single unit.

T F 19. Some op-amps require both positive and negative voltage supplies.

T F 20. Capacitor coupling is used to block excessive currents from the previous stage.

Unit XI--Electronic Devices
Test Key

1. Forward bias
2. cathode
3. common base, common collector, common emitter
4. the bias point at which a transistor no longer conducts
5. TRIAC
6. Can, DIP, flatpack
7. Zener
8. Forward
9. gate, source, drain
10. photoconductive cell
11. voltage multiplier
12. gain
13. false
14. true
15. true
16. true
17. false
18. true
19. true
20. true

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Unit XII--Circuit Fabrication
Sample Test

1. What type of pc board material is used where dimensional stability is not a concern?

   A. Epoxy glass
   B. Polyester glass
   C. Epoxy paper
   D. Phenolic paper

2. Copper foil is designated by the weight of the copper on the surface; the term "ounce" indicates

   A. ounces per square inch
   B. ounces per square foot
   C. ounces per square meter
   D. ounces per square centimeter

3. If you are using a one ounce copper clad board what would be the copper surface thickness?

   A. .001
   B. .002
   C. .003
   D. .004

4. Epoxy glass boards have approximately ____________________ times the flexural strength of phenolic-paper boards.

   A. 2
   B. 4
   C. 8
   D. 16

5. Which of the following PC boards would be the most expensive to purchase?

   A. Phenolic paper, one ounce single-sided board
   B. Epoxy glass, one ounce single-sided board
   C. Phenolic paper, one ounce single-sided, sensitized
   D. Epoxy glass, one ounce double-sided board, sensitized.

6. The chemical process used to remove unwanted copper from a PC board during the substractive process is called:

   A. laminating
   B. etching
   C. plating
   D. routing

7. Component leads usually require relatively small mounting holes, however on oversized holes, especially those ¼ inch and larger, you should

   A. increase the drill rpm
   B. exert greater feed pressure
   C. use a countersink
   D. drill a smaller pilot hole first

8. The entire process of printed circuit board design starts with a basic document which is the
   - A. master pattern
   - B. schematic diagram
   - C. block diagram
   - D. photo mask

9. What would be the most accurate aid for use in positioning full-size IC pad?
   - A. Reset ink pen
   - B. Rub-on transfer pads
   - C. Layout dolls
   - D. Crepe art tape

10. Before direct pattern artwork can be prepared on a circuit board, the board must be
    - A. etched
    - B. resist-coated
    - C. free of grease, dirt and fingerprints
    - D. exposed to light

11. When exposing a positive type photo-sensitized circuit board, ________________ light must be used.
    - A. subdued incandescent
    - B. incandescent
    - C. infrared
    - D. ultraviolet

12. Major circuit defects after etching, such as edge definition, pitting, and voids, can be caused by
    - A. poor adhesion of artwork
    - B. dirty copper surface
    - C. improper board preparation
    - D. all of the above

13. What is the safest etchant to make a printed circuit board?
    - A. ammonium persulfate
    - B. ferric chloride
    - C. cupric chloride
    - D. hydrochloric acid

14. What are the two methods of image transfer suitable for producing several identical circuit board patterns from a single piece of art work?
    - A. screen printing and direct pattern
    - B. screen printing and photoresist
    - C. direct etch and direct pattern
    - D. direct pattern and photoresist

15. When working with etchant chemicals in the shop, which of the following should you do for safety's sake?
    - A. stir etchants with kitchen utensils
    - B. pour etchants in aluminum trays for mixing
    - C. dispose of the contents after use
    - D. dispose of etchants in the sink

16. Name three tools which can be used for cutting PC boards.
    1.
    2.
    3.

17. A cutting tool used to chip off the excess length of component leads is called ______________________________ cutters.

18. Of the four common drill bit sizes listed below, which one has the smallest diameter?
    - A. 1/16 inch
    - B. No. 55
    - C. No. 60
    - D. No. 65

19. Of the following, which composition of solder for electronic work would work best?
    - A. Lead, nickel, and resin flux
    - B. Nickel, tin, and resin flux
    - C. Tin, lead, and resin flux
    - D. Tin, lead and acid flux

20. A good solder joint will appear
    - A. dull
    - B. rough
    - C. shiny
    - D. white

Unit XIII--Introduction to Computer Literacy
Sample Test

1. What is the difference between a microprocessor and a microcomputer?

2. VLSI chips contain at least _______________ transistors.

   A. 50
   B. 500
   C. 5,000
   D. 50,000

3. With what invention could mathematical manipulations be done electronically rather than mechanically by DeForet in 1906?

4. Memory that can be read or written by any selected random address is called _________________________.

   A. ROM
   B. RAM
   C. PROM
   D. EPROM

5. A term used in referring to groups of binary digits is called

   A. nibble
   B. CPU
   C. Byte
   D. bit

6. What is the smallest unit of information in a digital computer?

   A. Bit
   B. Byte
   C. Nibble
   D. RAM

7. Scientists were first to develop what programming language?

   A. Cobol
   B. Basic
   C. Fortran
   D. Assembler

8. A program which is normally prepared in typed form on paper and not designed into the circuitry is logically called _________________________.

9. Prior to magnetic dies what type of magnetic memory was available?

   A. Punch card
   B. Magnetic tape
   C. Paper tape
   D. All of the above

10. A device which contains arithmetic logic and control units in a single package is called a

    A. microprocessor
    B. programmable ROM
    C. main frame
    D. power supply

Unit XIII--Introduction to Computer Literacy
Test Key

1. A microcomputer is a system containing a microprocessor

2 D

3. Triode vacuum tube

4. B

5. C

6. A

7. Fortran

8. Software

9. B

10. A

Unit XIV--Robotics: An Introduction for Your Classroom
Sample Test

1. The word robot was first used by Czech novelist, essayist, and dramatist _________________ _________________ in 1921.

2. In what operation in manufacturing assembly do robots play the biggest part?

3. What industry uses the most industrial robots?

4. What are at least two classes or types of robots?

5. The hand or gripping device is usually attached to the end of the robot's _______________________________________.

6. The majority of the industrial robots are stationary? True or False

7. All robots consist of two major component systems. They are the the control system and the

   A. programmable memory
   B. stepper motors
   C. X & Y limit switches
   D. manipulators

8. List at least three ways a robot can grasp or otherwise handle a job.

   1.
   2.
   3.

9. The shape of the work envelope for a robot is determined almost entirely by what three major axes?

   1.
   2.
   3.

10. Name at least five possible robotic applications for the industrial arts classroom.

    1.
    2.
    3.
    4.
    5.

Unit XIV--Robotics: An Introduction for Your Classroom
Test Key

1. Karl Capek

2 welding

3. automobile

4. non-servo controlled, servo controlled and remote controlled

5. manipulator

6. true

7. D

8. Mechanical grippers, hooking on to a part, scooping or ladling, electromagnets, vacuum cups, quick disconnect bayonet sockets

9. 1. jointed arm
   2. spherical coordinate
   3. cylindrical coordinate configurations.

10. spot welding, arc welding, electronic component assembly, machine loading and unloading, material handling, assembly and quality control, research and development, metal casting, using wax instead of molten metal.

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Unit XV--Industrial Electricity/Electronics
Sample Test

1. Explain how electricity is produced in an AC generator.

2. Define counter EMF and explain its importance to the operation of electric motors.

3. Name four pieces of information found on motor name plates.

4. Name four types of AC motors.

5. Explain how heat is generated in spot welding.

6. List three uses (besides welding) for resistance heating.

True-False:

T F 7. Electricity can produce chemical reactions.

T F 8. Aluminum is refined by an electrolysis reaction.

T F 9. Oxygen can be separated from water by electricity.

T F 10. High frequency radio waves (microwaves) can be used to produce heat.

T F 11. Incandescent lights produce light by producing an arc in a gas.

T F 12. The speed of an AC motor is related to the voltage.

T F 13. Generators lose power.

T F 14. Copper can be electrically plated to other metals.

T F 15. Chlorine gas is produced by electrolysis of salt.

Unit XV--Industrial Electricity?Electronics
Test Key

1. As the armature revolves through the magnetic field, current is induced in the wire. The polarity and amplitude are dependent on speed and angle of armature.

2. Counter EMF is a voltage produced by a motor that opposes the applied voltage. Counter EMF limits the current in the motor to safe levels.

3.. Brand, speed, horsepower, voltage, current, cycle, phase, et al

4. Hysteresis, split phase, three phase, repulsion induction, shaded pole

5. As current passes through the weld the resistance of the junction of the dissimilar metals produces heat.

6. Incandescent lamps, arc lamps, radiant heating, infrared heating

7. True

8. True

9. True

10. True

11. False

12. False

13. True

14. True

15. True

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APPENDIX 2

TOOL LIST

Hand Tools

Alignment Tool (set)
Apron--Rubber/Solvent Resistant
Benders, EMT
Benders, Hickey
Bit, Auger (set)
Bit, Screwdriver (set)
Bit, Speed (set)
Brace, Ratchet
Brake, Box and pan
Breadboards
Brush, Drafting
Brush, Wire
Capacitor, Substitution Box
Chisel, Cold (set)
Coil Winder
Countersink, High Speed
Crimping Tool
Curve Tracer
Desoldering Tool
Die, Letter (set)
Die, Number (set)
Divider, Wing
Drafting Board
Drafting Equipment (set)
Drill, Electric, Portable (1/4")
Drill, Hand (1/4")
Drill Stand, Fractional)
Drill, Twist, (letter set)
Drill, Twist (number set)
Drill, Twist, Straight shank (fractional set)
Extension cord
Files (see specifications for listing)
File Card and Brush
File, Jeweler's (set)
File, Needle (set)
Fish Tape
Function/Signal Generator
Gauge, Screw pitch
Gauge, Thickness (feeler)
Gauge, Wire and sheet metal (American)
Gauge, Wire and sheet metal (U.S.S.)
Goggles (spectacles), Clean observation
Grinder, Pedestal
Hammer, Ball peen (12 oz. and 16 oz.)
Hammer, Claw (16 ox.)
I.C. Insertion/Extraction tool
Knife, Electrician's
Level
Light, Extension

Hand Tools (Continued)

Logic probe
Magnet, Bar
Magnet, Horseshoe
Meter, Ammeter
Meter, Galvanoment
Meter, Inductance
Meter, Volt-ohm (multi-range)
Meter, VTVM or Electronic
Neon Test Light
Nibbler, Hand operated
Oiler, Bench
Oilstone, Combination, India
Oilstone, Combination, Silicon carbide
Oscilloscope-15MHZ, Single tract
Oscilloscope-50MHZ, Dual trace
Pipe Cutter
Pipe Reamer
Pliers, Combination (6")
Pliers, Duckbill
Pliers, Diagonal cutting
Pliers, Needle nose
Pliers, Side-cutting
Pliers,, locking jaw
Power supply
Press, Drill
Punch, Center (set)
Punch, Chassis (round set)
Punch, Chassis (square set)
Punch, Pin (set)
Punch, Whitney hand
Reamer, Electrician's hand
Resistor, Substitution Box
Rule, Steel (12")
Rule, Folding
Saw, Coping
Saw, Hack (hand)
Saw, Hand, Crosscut
Saw, Reciprocal
Scissors
Screwdriver, Insulated (set)
Screwdrive, Phillips (set)
Screwdriver, Retaining type
Shear, Squaring foot
Shield, Face
Signal Tracer
Snip, Aviation (left)
Snip, Aviation (right)
Snips, Tinner's, Straight (#8)
Soldering Copper, Electric pencil
Soldering Pencil--controlled heat, ground tip

Hand Tools (Continued)

Soldering Gun, Electric
Square, Combination
Square, Steel Framing
Square, Try (6")
Strip Heater--Plastic
Tap and Die, NC (U.S. standard) (set)
Tap and Die, NF (S.A.E.) (set)
Tap and Die, Pipe (set)
Tester, Transistor
Tester, Tube
Tray--Plastic--Acid Resistant
Welder, Spot
Wire Wrapping tools--Hand
Wrench, Adjustable end (6")
Wrench, Allen key (hex) (set)
Wrench, Nutdriver (set)
Wrench, Open end (set)
Wrench, Socket (3/8") drive) (set)
Vise, Circuit Board

APPENDIX 3

FIRE EXTINGUISHERS

Fire Extinguisher

Each fire extinguisher bears a letter (which usually has a metallic or green background) which indicates what class of fire the extinguisher will successfully put out. Water types of extinguishers, which are effective for Class A fires, can be of several kinds: stored pressure, cartridge operated, water pump tank, and soda acid.

Foam extinguishers are successful for Class A and B fires, while carbon dioxide and sodium and potassium bicarbonate dry chemical extinguishers are effective for only Class B and C fires. Multipurpose ABC dry chemical extinguishers, in either stored pressure or cartridge operated types, work for A, B, or C classes of fires. Class D fires should only be fought with special extinguishing agents approved by recognized testing laboratories (see chart on the following page).

If clothing should catch on fire, avoid panic. The flames should be smothered by wrapping in a blanket or coat, or by rolling on the floor or ground.

Fire Prevention

1. Do not overload electrical circuits.

2. Do not use frayed or defective electrical cords.

3. Do not allow any electrical repairs to be made by the students unless they are supervised by the instructor.

4. Do not use gasoline for anything except to run an engine.

5. Do not prime the engine with gasoline while it is running.

6. Do not weld near gas tanks, fuel lines, or any combustible materials.

7. Retain gasoline and store it in a safety can only.

8. If a fire should occur, use the proper extinguishers (see chart on the following page).

   A. Carbon dioxide: all electrical equipment

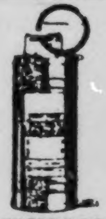
   B. Foam: oils, gasoline, grease, or paint

   C. Soda-acid: wood, cloth, paper or rubbish

   D. Vaporizing liquids: general purpose

9. If a fire cannot be readily extinguished, keep calm, evacuate the shop immediately, and turn in an alarm.

KNOW YOUR FIRE EXTINGUISHERS

DEPARTMENT OF LABOR · UNITED STATES OF AMERICA	WATER TYPE				FOAM	CARBON DIOXIDE	DRY CHEMICAL			
							SODIUM OR POTASSIUM BICARBONATE		MULTI-PURPOSE ABC	
	STORED PRESSURE	CARTRIDGE OPERATED	 WATER PUMP TANK	SODA ACID	FOAM	CO 2	CARTRIDGE OPERATED	STORED PRESSURE	STORED PRESSURE	CARTRIDGE OPERATED
CLASS A FIRES WOOD, PAPER, TRASH HAVING GLOWING EMBERS ORDINARY A COMBUSTIBLES	YES	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	YES	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	NO (BUT WILL CONTROL SMALL SURFACE FIRES)	YES	YES
CLASS B FIRES FLAMMABLE LIQUIDS, GASOLINE, OIL, PAINTS, GREASE, ETC. FLAMMABLE B LIQUIDS	NO		NO			YES	YES	YES	YES	YES
CLASS C FIRES ELECTRICAL EQUIPMENT ELECTRICAL C EQUIPMENT	NO		NO			YES	YES	YES	YES	YES
CLASS D FIRES COMBUSTIBLE METALS COMBUSTIBLE D METALS	SPECIAL EXTINGUISHING AGENTS APPROVED BY RECOGNIZED TESTING LABORATORIES									
METHOD OF OPERATION	PULL PIN-SQUEEZE HANDLE	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	PUMP HANDLE	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	OBSOLETE UPDATE YOUR FIRE EXTINGUISHING CAPABILITY— ASK FOR "TRADE-IN UPDATE" PRICE	PULL PIN-SQUEEZE LEVER	RUPTURE CARTRIDGE-SQUEEZE LEVER	PULL PIN SQUEEZE HANDLE	PULL PIN-SQUEEZE HANDLE	RUPTURE CARTRIDGE-SQUEEZE LEVER
RANGE	30' - 40'		30' - 40'			3' - 8'	5' - 20'	5' - 20'	5' - 20'	5' - 20'
MAINTENANCE	CHECK AIR PRESSURE GAUGE MONTHLY		DISCHARGE AND FILL WITH WATER ANNUALLY			WEIGH SEMI-ANNUALLY	WEIGH GAS CARTRIDGE-CHECK CONDITION OF DRY CHEMICAL ANNUALLY	CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY	CHECK PRESSURE GAUGE AND CONDITION OF DRY CHEMICAL ANNUALLY	WEIGH GAS CARTRIDGE-CHECK CONDITION OF DRY CHEMICAL ANNUALLY

NOTES:

Class D Fires - In hot metal areas which may use magnesium, titanium, zirconium, and sodium, one must provide Type D extinguishers or D rated dry chemical available for use on metal fires. It is important to use the correct extinguisher on the proper class of fire.

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APPENDIX 4

SAFETY RECORDKEEPING

Safety Recordkeeping

One of the primary reasons for keeping health and safety records is to focus attention on problem areas so that corrective measures can be taken. The evaluation of accidents that have occurred, using a specific form like the one presented in this section, requires that the instructor look for causes and make plans to correct any problems which may be present. Good safety recordkeeping in this area also provides a basis for evaluating the safety program in use and initiating needed changes in procedures or facilities.

Safety records may also help to protect the instructor and the institution in the event of lawsuits. Although parental permission forms, safety tests, and safety instruction records do not provide a complete defense against such actions, they do tend to show the instructor was acting in "good faith" and may be construed as a partial defense in some courts.

Sample record forms, both a school's records and an instructor's records, are presented at the end of this unit. They may be reproduced or modified to fit the needs of a particular teacher or institution. The purpose or use of these forms is outlined below. Also included are copies of OSHA forms #100, #101, and #102, required of businesses and institutions that are under OSHA provisions.

School Records

1. Accident forms

    A. Accident reports should be made out as soon as possible after an accident has occurred. Copies of the reports should be retained in the instructor's file. Additional copies should be filed in the appropriate administrative offices.

    B. A variety of accident report forms are available; however, they should all contain the following information when completed.

        1. What was the nature of the accident? What were the circumstances leading up to the accident? What was the nature of the injuries or damage? What were the persons involved doing? What unsafe act or acts were committed? What were the direct or indirect causes? What machine, tool, substance, or object was most closely connected with the accident? What corrective action is indicated?

        2. Who was injured or nearly injured? Who were the participants in the accident? Who committed the unsafe act? Who were the witnesses? Who administered first aid to the injured? Who completed the accident report?

        3. Where did the accident occur? Where was the instructor at the time of the accident? Where was the injured person with respect to the machine, tool, substance, object, or person most closely associated with the accident?

4. When did the accident occur? When was the accident investigation made? When was the accident report completed?

5. Why was the unsafe act or hazardous condition permitted? Why did the person act unsafely? Why did the accident occur?

6. How did the accident happen? How did the physical environment contribute to the accident? How can similar future accidents be prevented?

II. Records of Safety Committee Meetings

Each institution's safety committee should meet periodically to discuss the safety program being used and to review recommendations for improving the program.

III. Safety Inspection Records

Records of every inspection conducted in the vocational education and industrial arts laboratory should be filed by the institution.

IV. School-Wide Safety Efforts and Programs

Information detailing the program in use in the school should be on file in the main office.

Teacher Records

1. Safety Instruction Records

Records of safety inspections, schedules of safety talks, and signed sheets acknowledging safety instruction should be kept by the instructor.

II. Parental Permission/Consent Forms

Written parental permission should be obtained before minor students are permitted to use tools and operate equipment in industrial education laboratories. The purpose of this permission is to emphasize that safety is a cooperative effort, and to impress upon both students and parents that there is a certain degree of danger invoved in the use of tools and equipment. It also offers the parent the option to prohibit the student's use of tools or equipment, if so desired.

III. Safety Tests

Instructors should administer appropriate safety tests to students before allowing them to use tools or equipment which could cause injury. The completed tests should be filed for reference. In addition to the test, a "statement of acknowledgment" should be filed with the safety test.

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IV. Hazardous Conditions Reports

Any potential health or safety hazard should be reported in writing. Reports should be kept on file, noting the action that has been taken to alleviate the hazardous conditon.

OSHA Records

Records required by the Federal Occupational Safety and Health Act are included here to provide administrators and instructors a guide for some other types of records.

I. Form #100 - Log of Occupational Injuries and Illnesses
II. Form #101 - Supplementary Record of Occupational Injuries and Illnesses
III. Form #102 - Summary of Occupational Injuries and Illnesses for Calendar Year

STANDARD STUDENT ACCIDENT REPORT FORM
Part A. Information on ALL Accidents

1. Name: ______________________ Home Address: ______________________
2. School: ______________________ Sex: M ☐ F ☐ Age ___ Grade or classification: ___
3. Time accident occurred: Hour ______ A.M. ______ P.M. Date: ______________
4. Place of Accident: School Building ☐ School Grounds ☐ To or from School ☐ Home ☐ Elsewhere ☐

5. NATURE OF INJURY

Abrasion ___
Amputation ___
Asphyxiation ___
Bite ___
Bruise ___
Burn ___
Concussion ___
Cut ___
Dislocation ___
Other (specify) ______

Fracture ___
Laceration ___
Poisoning ___
Puncture ___
Scalds ___
Scratches ___
Shock (el.) ___
Sprain ___

PART OF BODY INJURED

Abdomen ___
Ankle ___
Arm ___
Back ___
Chest ___
Ear ___
Elbow ___
Eye ___
Face ___
Finger ___
Other (specify) ______

Foot ___
Hand ___
Head ___
Knee ___
Leg ___
Mouth ___
Nose ___
Scalp ___
Tooth ___
Wrist ___

DESCRIPTION OF THE ACCIDENT

How did accident happen? What was student doing? Where was student? List specifically unsafe acts and unsafe conditions existing. Specify any tool, machine or equipment involved.

6. Degree of Injury: Death ☐ Permanent Impairment ☐ Temporary Disability ☐ Nondisabling ☐
7. Total number of days lost from school: ___ (To be filled in when student returns to school)

Part B. Additional Information on School Jurisdiction Accidents

8. Teacher in charge when accident occurred (enter name) ______________
Present at scene of accident: No ___ Yes ___

9. IMMEDIATE ACTION TAKEN

First-aid treatment ___ By (name): ______________
Sent to school nurse ___ By (name): ______________
Sent home ___ By (name): ______________
Sent to physician ___ By (name): ______________
Physician's Name: ______________
Sent to hospital ___ By (name): ______________
Name of Hospital: ______________

10. Was a parent or other individual notified? No ___ Yes ___ When ______ How ______
Name of parent notified ______________
By whom? (enter name) ______________

1. Witnesses: 1. Name ______________ Address ______________
2. Name ______________ Address ______________

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12. LOCATION	Specify Activity		Specify Activity
Athletic field	________	Locker	________
Auditorium	________	Pool	________
Cafeteria	________	Sch. grounds	________
Classroom	________	________ shop	________
Corridor	________	Showers	________
Dressing room	________	Stairs	________
Gymnasium	________	Toilets & washrooms	________
Home Econ.	________		
Laboratories	________	Other (specify)	________

Remarks

What recommendations do you have fo preventing other accidents of this type? ________________

Signed: Principal ____________________ Teacher ____________________

CAUSE: Unsafe Acts (mark basic cause)

1. ☐operating without authority
2. ☐operating at unsafe speed
3. ☐making safety device inoperative
4. ☐using unsafe equipment or ☐equipment unsafely
5. ☐unsafe loading, placing, mixing
6. ☐taking unsafe position
7. ☐working on moving or dangerous equipment
8. ☐distraction, teasing, horseplay
9. ☐failure to use personal protective devices

Why was the unsafe act committed? ________

Unsafe conditions (mark contributing cause,if an

10. ☐inadequately guarded
11. ☐defective tools, equipment or substance
12. ☐hazardous arrangement
13. ☐unsafe illumination
14. ☐unsafe ventilation
15. ☐unsafe clothing
16. ☐unguarded
17. ☐unsafe design or construction

Why did the unsafe condition exist? ________

GUIDES TO CORRECTIVE ACTION:

Unsafe Act

1. Stop
2. Study
3. Instruct (tell--show--try--check)
4. Train
5. Maintain discipline

Unsafe Condition

1. Remove
2. Guard
3. Warn

   If supervisor can't handle, then

4. Recommend for
   - (a) own supervisor, or
   - (b) other supervisors, or
   - (c) safety committee, or
   - (d) maintenance dept., or
   - (e) ________
5. Follow up

Based on the cause checked above, indicate below the corrective action you are taking.

What have you done to prevent similar injuries? ________________

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MINUTES OF SAFETY COMMITTEE MEETING

School__________ Date__________

Address__________ Time Meeting Opened__________

Members Present: Absent:

Minutes of previous meeting dated__________ were read.

Comments:__________

UNFINISHED BUSINESS AND OLD RECOMMENDATIONS, BY NUMBER ONLY, NOT DISPOSED OF:

RECOMMENDATIONS COMPLETED SINCE LAST MEETING: (Record by recommendation number only)

NEW BUSINESS:

__________Inspection reports were reviewed and discussed.

NEW RECOMMENDATIONS: (Number consecutively from previous recommendations and describe.)

REMARKS: The following accidents which occurred since the last meeting were discussed:

Date of Injury	Employee	Cause	Recommendations

OTHER COMMITTEE REMARKS:__________

Are Safety Posters being regularly received and posted?__________

Put additional remarks on the reverse side

Meeting adjourned__________ Next meeting to be held__________

Signed__________

Secretary of Committee

ACKNOWLEDGEMENT OF SAFETY INSTRUCTION AND PLEDGE

I have received the SAFETY INSTRUCTIONS regarding the operation of the following power driven machines. I fully understand the importance of these rules and regulations, and I am fully aware that the violation of any one of them may endanger myself and others.

My instructor has demonstrated to me the proper methods of using each machine listed below and has pointed out the safety precautions necessary to avoid injury.

I have demonstrated my ability to use each machine listed below in the presence of my teacher. I understand the safety precautions involved and I understand how to ensure my safety through the proper use of the machines. I am confident that I can operate these machines safely. When in doubt about the operation of any machine or other equipment, I will consult the teacher before proceeding.

(Name of each machine to be written in by the pupil after he/she has passed the safety test and demonstrated the ability to use it.)

NAME OF MACHINE	DATE	STUDENT'S SIGNATURE	TEACHER'S INITIALS
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

I have passed the tests covering safety in the shop and the use of the above-listed machines.

I promise to observe the SAFETY INSTRUCTIONS and to follow the instructions given in the demonstration. I may use the machines only after I have been properly instructed in their safe use, and I have received the approval of the teacher.

School ______________________ Signed ______________________
pupil

Date ______________ Instructor ______________________

SAMPLE PERMISSION FORM

________________________________ has our/my permission to operate the
(student's name)
equipment in the ________________________________ laboratory
at ________________________________ School. It is understood that instruction in its safe operation will be given before he/she is allowed to use any piece of equipment and that he/she will be properly supervised at all times.

In the case of an accident, it is preferred that he/she be given treatment by:

Dr: ________________________________

or Dr: ________________________________

Our home phone number is: ________________________________

Our work phone number is: ________________________________

If neither parent/guardian can be reached at the above numbers, please notify:

________________________ at ________________________
(responsible person) (telephone number)

Date: ________________________

Signed: ________________________
(father/guardian)

____
(mother/guardian)

____
(other—specify relationship)

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HAZARDOUS CONDITIONS REPORT

Date________________

TO____

(Building Administrator) (Position) (School)

Description and Location of Health or Safety Hazard

____

____

____

Suggested Solution

____

____

____

Teacher's signature ____________________

Distribution: Original - Building Administrator
1st Copy - Department Chairperson
2nd Copy - Teacher Reporting Hazard
3rd Copy - Parish Safety Officer

Action Taken

____

____

____

By Whom________________________

(Signature)

OSHA NO. 100

LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

RECORDABLE CASES: You are required to record information about every occupational death, every nonfatal occupational illness, and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid).
More complete definitions appear on the other side of this form.

Form Approved
OMB No. 44R 1453

					DESCRIPTION OF INJURY OR ILLNESS		EXTENT OF AND OUTCOME OF CASES					
								LOST WORKDAY CASES			NONFATAL CASES WITHOUT LOST WORKDAYS (Enter a check if no entry was made in columns 8 or 9 but the case is recordable, as defined above.)	TERMINATIONS OR PERMANENT TRANSFERS (Enter a check if the entry in columns 9 or 10 represented a termination or permanent transfer.)
									LOST WORKDAYS			
CASE OR FILE NUMBER	DATE OF INJURY OR ONSET OF ILLNESS	EMPLOYEE'S NAME (First name or initial, middle initial, last name)	OCCUPATION (Enter regular job title, not activity employee was performing when injured or at onset of illness.)	DEPARTMENT (Enter department in which the employee is regularly employed.)	Nature of Injury or Illness and Part(s) of Body Affected (Typical entries for this column might be: Amputation of 1st joint right forefinger; Strain of lower back; Contact dermatitis on both hands; Electrocution—body)	Injury or Illness Code (See codes at bottom of page.)	DEATHS (Enter date of death.)	Enter a check if case involved lost workdays.	Enter number of days AWAY FROM WORK due to injury or illness.	Enter number of days of RESTRICTED WORK ACTIVITY due to injury or illness.		
(1)	Mo./day/yr. (2)	(3)	(4)	(5)	(6)	(7)	Mo./day/yr. (8)	(9)	(9A)	(9B)	(10)	(11)

Company Name ______________________

Establishment Name ______________________

Establishment Address ______________________

NOTE: This is NOT a report form. Keep it in the establishment for 5 years.

Injury Code
10 All occupational injuries
Illness Codes

21 Occupational skin diseases or disorders
22 Dust diseases of the lungs (pneumoconioses)
23 Respiratory conditions due to toxic agents
24 Poisoning (systemic effects of toxic materials)
25 Disorders due to physical agents (other than toxic materials)
26 Disorders associated with repeated trauma
29 All other occupational illnesses

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CHANGES IN EXTENT OF OR OUTCOME OF INJURY OR ILLNESS

If, during the 5-year period the log must be retained, there is a change in a case which affects entries in columns 9 or 10, the first entry should be lined out and a new entry made. For example, if an injured employee at first required only medical treatment but later lost workdays, the check in column 10 should be lined out, a check entered in column 9, and the number of lost workdays entered in columns 9A and/or 9B.

In another example, if an employee with an occupational illness lost workdays, returned to work, and then died of the illness, the entries in columns 9, 9A, and/or 9B should be lined out and the date of death entered in column 8.

The entire entry for a case should be lined out if the case is later found to be nonrecordable. Examples are: A case which is later determined not to be work related, or a case which was initially thought to involve medical treatment but later was determined to have involved only first aid.

DEFINITIONS

RECORDABLE OCCUPATIONAL INJURIES AND ILLNESSES are:

1) OCCUPATIONAL DEATHS, regardless of the time between injury and death, or the length of the illness; or

2) OCCUPATIONAL ILLNESSES; or

3) OCCUPATIONAL INJURIES which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment other than first aid.)

NOTE: Any case which involves lost workdays must be recorded since it always involves one or more of the criteria for recordability.

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, amputation, etc., which results from a work accident or from an exposure involving a single incident in the work environment.

NOTE: Conditions resulting from animal bites, such as insect or snake bites, or from one-time exposure to chemicals are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact.

The following listing gives the categories of occupational illnesses and disorders that will be utilized for the purpose of classifying recordable illnesses. The identifying codes are those to be used in column 7 of the log. For purposes of information, examples of each category are given. These are typical examples, however, and are not to be considered to be the complete listing of the types of illnesses and disorders that are to be counted under each category.

(21) Occupational Skin Diseases or Disorders
Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants, oil acne, chrome ulcers, chemical burns or inflammations, etc.

(22) Dust Diseases of the Lungs (Pneumoconioses)
Examples: Silicosis, asbestosis, coal worker's pneumoconiosis, byssinosis, and other pneumoconioses.

(23) Respiratory Conditions Due to Toxic Agents
Examples: Pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes, farmer's lung, etc.

(24) Poisoning (Systemic Effects of Toxic Materials)
Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals, poisoning by carbon monoxide, hydrogen sulfide or other gases, poisoning by benzol, carbon tetrachloride, or other organic solvents, poisoning by insecticide sprays such as parathion, lead arsenate, poisoning by other chemicals such as formaldehyde, plastics and resins, etc.

(25) Disorders Due to Physical Agents (Other Than Toxic Materials)
Examples: Heatstroke, sunstroke, heat exhaustion and other effects of environmental heat, freezing, frostbite and effects of exposure to low temperatures, caisson disease, effects of ionizing radiation (isotopes, X-rays, radium); effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn) etc.

(26) Disorders Associated With Repeated Trauma
Examples: Noise-induced hearing loss, synovitis, tenosynovitis, and bursitis, Raynaud's phenomena, and other conditions due to repeated motion, vibration or pressure.

(29) All Other Occupational Illnesses
Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumors, food poisoning, histoplasmosis, coccidioidomycosis, etc.

MEDICAL TREATMENT includes treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does NOT include first aid treatment (one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care) even though provided by a physician or registered professional personnel.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed (for example: a factory, mill, store, hotel, restaurant, movie theater, farm, ranch, bank, sales office, warehouse, or central administrative office). Where distinctly separate activities are performed at a single physical location (such as contract construction activities operated from the same physical location as a lumber yard), each activity shall be treated as a separate establishment.

For firms engaged in activities such as agriculture, construction, transportation, communications, and electric, gas and sanitary services, which may be physically dispersed, records may be maintained at a place to which employees report each day.

Records for personnel who do not primarily report or work at a single establishment, such as traveling salesmen, technicians, engineers, etc., shall be maintained at the location from which they are paid or the base from which personnel operate to carry out their activities.

WORK ENVIRONMENT is comprised of the physical location, equipment, materials processed or used, and the kinds of operations performed by an employee in the performance of his work, whether on or off the employer's premises.

LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

Each employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must maintain for each establishment a log of all recordable occupational injuries and illnesses. This form (OSHA No. 200) may be used for that purpose. A substitute for the OSHA No. 200 is acceptable if it is as detailed, easily readable and understandable as the OSHA No. 200.

Each recordable occupational injury and occupational illness must be timely entered on the log. Logs must be kept current and retained for five (5) years following the end of the calendar year to which they relate. Logs must be available (normally at the establishment) for inspection and copying by representatives of the Department of Labor, or the Department of Health, Education and Welfare, or States accorded jurisdiction under the Act.

INSTRUCTIONS FOR COMPLETING LOG OF OCCUPATIONAL INJURIES AND ILLNESSES

Column 1 - CASE OR FILE NUMBER

Enter a number which will facilitate comparison with supplementary records. Any series of nonduplicating numbers may be used.

Column 2 - DATE OF INJURY OR ONSET OF ILLNESS

For occupational injuries, enter the date of the work accident which resulted in injury. For occupational illnesses, enter the date of initial diagnosis of illness, or, if absence from work occurred before diagnosis, enter the first day of the absence attributable to the illness which was later diagnosed or recognized.

Column 3 - EMPLOYEE'S NAME

Column 4 - OCCUPATION

Enter regular job title, not the specific activity being performed at time of injury or illness. In the absence of a formal occupational title, enter a brief description of the duties of the employee.

Column 5 - DEPARTMENT

Enter the name of the department or division in which the injured person is regularly employed, even though temporarily working in another department at the time of injury or illness. In the absence of formal department titles, enter a brief description of normal workplace to which employee is assigned.

Column 6 - NATURE OF INJURY OR ILLNESS AND PART(S) OF BODY AFFECTED

Enter a brief description of the injury or illness and indicate the part or parts of body affected. Where entire body is affected, the entry "body" can be used.

Column 7 - INJURY OR ILLNESS CODE

Enter the one code which most accurately describes the case. A list of the codes appears at the bottom of the log. A more complete description of recordable occupational injuries and illnesses appears in "DEFINITIONS."

Column 8 - DEATHS

If the occupational injury or illness resulted in death, enter date of death.

Column 9 - LOST WORKDAY CASES

Enter a check for each case which involves days away from work, or days of restricted work activity, or both. Each lost workday case also requires an entry in column 9A or column 9B, or both.

Column 9A - LOST WORKDAYS: DAYS AWAY FROM WORK

Enter the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

NOTE: For employees not having a regularly scheduled shift, i.e., certain truck drivers, construction workers, farm labor, casual labor, part-time employees, etc., it may be necessary to estimate the number of lost workdays. Estimates of lost workdays shall be based on prior work history of the employee AND days worked by employees, not ill or injured, working in the department and/or occupation of the ill or injured employee.

Column 9B - LOST WORKDAYS: DAYS OF RESTRICTED WORK ACTIVITY

Enter the number of workdays (consecutive or not) on which because of injury or illness:

1) the employee was assigned to another job on a temporary basis, or
2) the employee worked at a permanent job less than full time, or
3) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

Column 10 - NONFATAL CASES WITHOUT LOST WORKDAYS

Enter a check for any recordable case which does not involve a fatality or lost workdays.

Column 11 - TERMINATIONS OR PERMANENT TRANSFERS

Enter a check if the entry in columns 9 or 10 represented a termination of employment or permanent transfer.

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OSHA No. 101
Case or File No. ....

Form approved
OMB No. 44R 1453

Supplementary Record of Occupational Injuries and Illnesses

EMPLOYER

1. Name ....
2. Mail address ....
(No. and street) (City or town) (State)
3. Location, if different from mail address ....

INJURED OR ILL EMPLOYEE

4. Name .... Social Security No. ....
(First name) (Middle name) (Last name)
5. Home address ....
(No. and street) (City or town) (State)
6. Age .... 7. Sex: Male............ Female............ (Check one)
8. Occupation ....
(Enter regular job title, not the specific activity he was performing at time of injury.)
9. Department ....
(Enter name of department or division in which the injured person is regularly employed, even though he may have been temporarily working in another department at the time of injury.)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure ....
(No. and street) (City or town) (State)

If accident or exposure occurred on employer's premises, give address of plant or establishment in which it occurred. Do not indicate department or division within the plant or establishment. If accident occurred outside employer's premises at an identifiable address, give that address. If it occurred on a public highway or at any other place which cannot be identified by number and street, please provide place references locating the place of injury as accurately as possible.

11. Was place of accident or exposure on employer's premises? .... (Yes or No)
12. What was the employee doing when injured? ....
(Be specific. If he was using tools or equipment or handling material, name them and tell what he was doing with them.)
13. How did the accident occur? ....
(Describe fully the events which resulted in the injury or occupational illness. Tell what happened and how it happened. Name any objects or substances involved and tell how they were involved. Give full details on all factors which led or contributed to the accident. Use separate sheet for additional space.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

14. Describe the injury or illness in detail and indicate the part of body affected. ....
(e.g.: amputation of right index finger at second joint; fracture of ribs; lead poisoning; dermatitis of left hand, etc.)
15. Name the object or substance which directly injured the employee. (For example, the machine or thing he struck against or which struck him; the vapor or poison he inhaled or swallowed; the chemical or radiation which irritated his skin; or in cases of strains, hernias, etc., the thing he was lifting, pulling, etc.)
16. Date of injury or initial diagnosis of occupational illness ....
(Date)
17. Did employee die? .... (Yes or No)

OTHER

18. Name and address of physician ....
19. If hospitalized, name and address of hospital ....

Date of report .... Prepared by ....
Official position ....

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SUPPLEMENTARY RECORD OF OCCUPATIONAL INJURIES AND ILLNESSES

To supplement the Log of Occupational Injuries and Illnesses (OSHA No. 100), each establishment must maintain a record of each recordable occupational injury or illness. Workmen's compensation, insurance, or other reports are acceptable as records if they contain all facts listed below or are supplemented to do so. If no suitable report is made for other purposes, this form (OSHA No. 101) may be used or the necessary facts can be listed on a separate plain sheet of paper. These records must also be available in the establishment without delay and at reasonable times for examination by representatives of the Department of Labor and the Department of Health Education and Welfare, and States accorded jurisdiction under the Act. The records must be maintained for a period of not less than five years following the end of the calendar year to which they relate.

Such records must contain at least the following facts:

1) *About the employer*—name, mail address, and location if different from mail address.

2) *About the injured or ill employee*—name, social security number, home address, age, sex, occupation, and department.

3) *About the accident or exposure to occupational illness*—place of accident or exposure, whether it was on employer's premises, what the employee was doing when injured, and how the accident occurred.

4) *About the occupational injury or illness*—description of the injury or illness, including part of body affected; name of the object or substance which directly injured the employee; and date of injury or diagnosis of illness.

5) *Other*—name and address of physician; if hospitalized, name and address of hospital; date of report; and name and position of person preparing the report.

SEE *DEFINITIONS* ON THE BACK OF OSHA FORM 100.

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OSHA No. 102

Complete no later than one month after close of calendar year. See back of this form for posting requirements and instructions.

Form Approved
OMB No. 44R 1453

SUMMARY
OF
OCCUPATIONAL INJURIES AND ILLNESSES
FOR CALENDAR YEAR 19__

Use previous edition of this form for summarizing your 1974 cases. This edition is for summarizing your cases for 1975 and subsequent years.

Establishment:
NAME ______________________________
ADDRESS ______________________________

INJURY AND ILLNESS CATEGORY			TOTAL CASES	DEATHS	LOST WORKDAY CASES				NONFATAL CASES WITHOUT LOST WORKDAYS	TERMINATIONS OR PERMANENT TRANSFERS
					Total Lost Workday Cases	Cases Involving Days Away From Work	Days Away From Work	Days of Restricted Work Activity		
	CATEGORY	CODE	Number of entries in Col. 7 of the log. (1)	Number of entries in Col. 8 of the log. (2)	Number of checks in Col. 9 of the log. (3)	Number of entries in Col. 9A of the log. (4)	Sum of entries in Col. 9A of the log. (5)	Sum of entries in Col. 9B of the log. (6)	Number of checks in Col. 10 of the log (7)	Number of checks in Col. 11 of the log (8)
OCCUPATIONAL INJURIES		10								
OCCUPATIONAL ILLNESSES	Occupational Skin Diseases or Disorders	21								
	Dust Diseases of the Lungs	22								
	Respiratory Conditions Due to Toxic Agents	23								
	Poisoning (Systemic Effects of Toxic Materials)	24								
	Disorders Due to Physical Agents	25								
	Disorders Associated With Repeated Trauma	26								
	All Other Occupational Illnesses	29								
	TOTAL–OCCUPATIONAL ILLNESSES (Sum of codes 21 through code 29)	30								
TOTAL–OCCUPATIONAL INJURIES AND ILLNESSES (Sum of code 10 and code 30)		31								

This is NOT a report form. Keep it in the establishment for 5 years.

I certify that this Summary of Occupational Injuries and Illnesses is true and complete, to the best of my knowledge.

Signature ______________________________
Title ______________________________
Date ______________________________

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SUMMARY OF OCCUPATIONAL INJURIES AND ILLNESSES

Every employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must use this form to prepare an annual summary of the occupational injury and illness experience of the employees in each of his establishments within one month following the end of each year.

POSTING REQUIREMENTS: A copy or copies of the summary must be posted at each establishment in the place or places where notices to employees are customarily posted. This summary must be posted no later than February 1 and must remain in place until March 1.

INSTRUCTIONS for completing this form: All entries must be summarized from the log (OSHA No. 100) or its equivalent. Before preparing this summary, review the log to be sure that entries are correct and each case is included in only one of the following classes deaths (date in column 8), lost workday cases (check in column 9), or nonfatal cases without lost workdays (check in column 10). If an employee's loss of workdays is continuing at the time the summary is being made, estimate the number of future workdays he will lose and add that estimate to the workdays he has already lost and include this total in the summary. No further entries are to be made with respect to such cases in the next year's summary.

Occupational injuries and the seven categories of occupational illnesses are to be summarized separately. Identify each case by the code in column 7 of the log of occupational injuries and illnesses.

The summary from the log is made as follows:

A. For occupational injuries (identified by a code 10 in column 7 of the log form) make entries on the line for code 10 of this form.

Column 1—Total Cases. Count the number of entries which have a code 10 in column 7 of the log. Enter this total in column 1 of this form. This is the total of occupational injuries for the year.
Column 2—Deaths. Count the number of entries (date of death) for occupational injuries in column 8 of the log.
Column 3—Total Lost Workday Cases. Count the number of checks for occupational injuries in column 9 of the log.
Column 4—Cases Involving Days Away From Work. Count the number of entries for occupational injuries in column 9A of the log.
Column 5—Days Away From Work. Add the entries (total days away) for occupational injuries in column 9A of the log.
Column 6—Days of Restricted Work Activity. Add the entries (total of such days) for occupational injuries in column 9B of the log.
Column 7—Nonfatal Cases Without Lost Workdays. Count the number of checks for occupational injuries in column 10 of the log.
Column 8—Terminations or Permanent Transfers. Count the number of checks for occupational injuries in column 11 of the log.
CHECK: If the totals for code 10 have been entered correctly, the sum of columns 2, 3, and 7 will equal the number entered in column 1

B. Follow the same procedure for each illness code, entering the totals on the appropriate line of this form.

C. Add the entries for codes 21 through 29 in each column for occupational illnesses and enter totals on the line for code 30.

D. Add the entries for codes 10 and 30 in each column and enter totals on the line for code 31.

CHECK: If the summary has been made correctly, the entry in column 1 of the total line (code 31) of this form will equal the total number of cases on the log.

The person responsible for the preparation of the summary shall certify that it is true and complete by signing the statement on the form.

Use previous edition of this form for summarizing your 1974 cases. This edition is for summarizing your cases for 1975 and subsequent years. Forms for the 1974 summary can be obtained from the appropriate State statistical grant agency (if there is one in your State) or from the appropriate Regional Office of the Bureau of Labor Statistics. Addresses are in the booklet entitled Recordkeeping Requirements under the Occupational Safety and Health Act of 1970.

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APPENDIX 5

MATH REVIEW

MATH REVIEW

I. Rounding Numbers

1. What is 4386 rounded to the nearest ten?

   a) 4280 b) 4380 c) 4390 d) 4400

2. What is 643,849 rounded to the nearest thousand?

   a) 643,850 b) 643,800 c) 644,000 d) 640,000

3. What is 9,675,000 rounded to the nearest hundred thousand?

   a) 9,670,000 b) 9,675,000 c) 9,680,000 d) 9,700,000

II. Add and Subtract Integers

4. $$\begin{array}{r} 4326 \\ 9857 \\ 2015 \\ +5634 \\ \hline \end{array}$$

   a) 22,833 b) 21,832 c) 21,742 d) 21,732

5. 3804 + 527 + 96 + 12,485 = ________________

   a) 16,912 b) 15,902 c) 15,911 d) 124,912

6. $$\begin{array}{r} 512,705 \\ -49,638 \\ \hline \end{array}$$

   a) 463,169 b) 473,177 c) 463,067 d) 463,077

III. Multiply and Divide Integers

7. $$\begin{array}{r} 836 \\ \text{x}79 \\ \hline \end{array}$$

   a) 56,044 b) 65,044 c) 66,046 d) 66,044

8. 987 x 456 _________

   a) 440,172 b) 450,072 c) 450,182 d) 451,072

9. 6300 ÷ 97 = _________

   a) 64 92/97 b) 65 95/97 c) 65 85/97 d) 66

10. 1498 ÷ 49 = ________

    a) 3 28/49 b) 31 c) 32 30/49 d) 30 4/7

IV. Add and Subtract Fractions

11. $$\begin{array}{r} 7\ 5/6 \\ +2\ 3/6 \\ \hline \end{array}$$

    a) 9 2/6 b) 10 1/3 c) 10 1/2 d) 10 8/6

12. 5 1/2 + 2 5/8 = __________

    a) 9 1/8 b) 7 6/10 c) 8 9/3 d) 7 6/16

13. 17 3/8
-12 7/8 a) 4 6/8 b) 5 3/4 c) 4 1/2 d) 5 1/2

14. 9 2/3 - 5 1/4 = ________

a) 4 1/4 b) 4 11/12 c) 3 5/12 d) 4 5/12

V. Multiply Fractions

15. 5/6 x 426 = _____
a) 71 b) 210 c) 355 d) 356

16. 3 3/5 x 8/9 = _____

a) 24/15 b) 3 24/45 c) 3 d) 3 1/5

17. 12 x 8 3/4 = _______

a) 96 3/4 b) 105 c) 72 d) 100

18. 8 2/5 x 6 2/3 = _____

a) 56 b) 48 4/15 c) 48 4/8 d) 46

VI. Divide Fractions

19. 15 ÷ 9/10 = ______

a) 9 10/15 b) 10 9/15 c) 13 1/2 d) 16 2/3

20. 6 2/3 ÷ 4 = ______

a) 1 1/2 b) 1 1/2 c) 1 2/3 d) 1 3/4

21. 8 2/3 ÷ 2/3 = ______

a) 8 b) 13 c) 16 2/3 d) 17 1/3

22. 3 3/8 ÷ 2 1/4 = ______

a) 1 1/2 b) 1 3/4 c) 2 3/8 d) 6 3/32

VII. Convert Fractions and Decimals

23. Change 3/4 to a decimal.

a) 0.075 b) 0.75 c) 7.5 d) 75.0

24. Change 1/2 to a decimal.

a) 2.0 b) 0.02 c) 0.2 d) 0.5

25. Change 0.3 to a fraction in lowest terms.

a) 3/100 b) 1/3 c) 3/10 d) 3

26. Change 0.07 to a fraction in lowest terms.

a) 7/100 b) 7/10 c) 1/7 d) 7

VIII. Add and Subtract Decimals

27. 0.982 + 0.7 + 0.65 = ______

a) 1.054 b) 1.117 c) 2.332 d) 9.117

28. 53.869 + 42.75 = __________

a) 95.944 b) 96.619 c) 58.144 d) 95.619

29. 0.071 - 0.06 = _______

a) 0.065 b) 0.067 c) 0.076 d) 0.011

30. 0.607 - 0.438 = ________

a) 0.231 b) 0.169 c) 0.179 d) 0.279

IX. Multiply Decimals

31. $\begin{array}{r} 0.695 \\ \underline{\times\ 86} \end{array}$ a) 0.5977 b) 5.977 c) 59.77 d) 58.97

32. 0.67 x 0.48 = _______

a) 0.3226 b) 0.3216 c) 3.216 d) 32.16

33. 0.609 x 3.80 = ______

a) 2.3142 b) 0.23142 c) 2.31402 d) 0.2314

34. $\begin{array}{r} 5.26 \\ \underline{\times 3.5} \end{array}$ a) 174.1 b) 184.10 c) 17.410 d) 18.41

X. Divide Decimals

35. $25\overline{)53.25}$ a) 0.23 b) 0.213 c) 2.013 d) 2.13

36. 8.001 ÷ 0.7 = ______

a) 1.143 b) 10.43 c) 11.43 d) 114.3

37. 62.5 ÷ 0.25 = _____

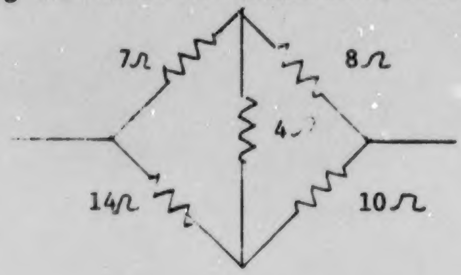
a) 25 b) 250 c) 205 d) 0.25

38. 2.193 ÷ 0.215 = ____

a) 1.20 b) 12 c) 10.2 d) 102

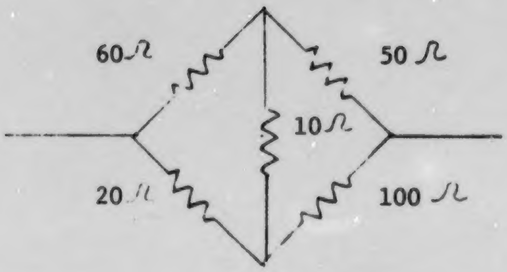
Using the Delta-Tee formulas to solve these problems:

(1)



9.1Ω

(2)



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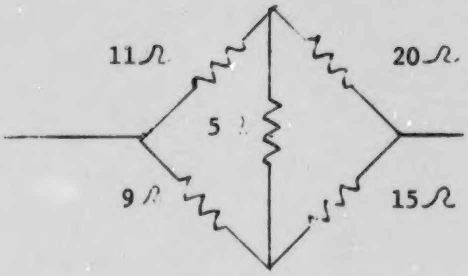
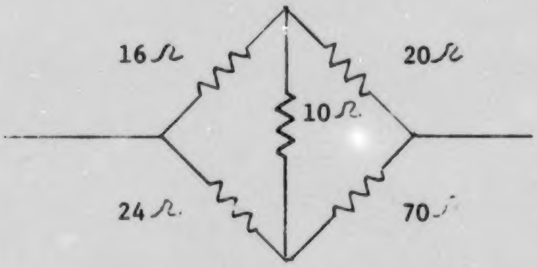


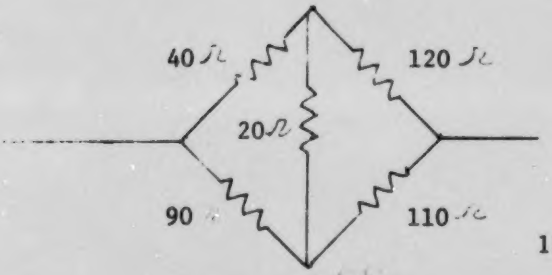
13.6

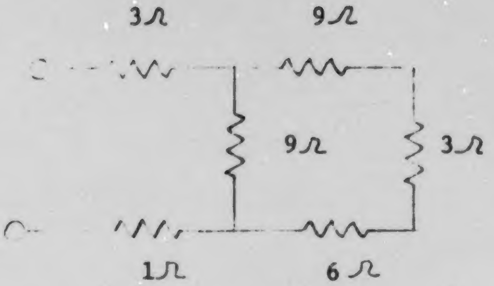
(4)



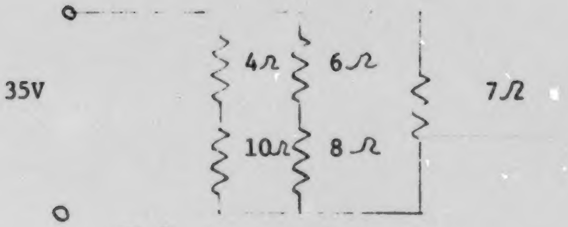
233

(5)

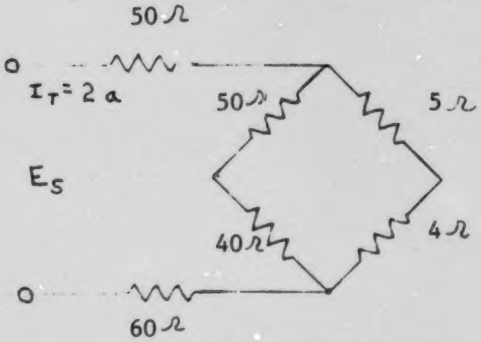




R_t = ____________________

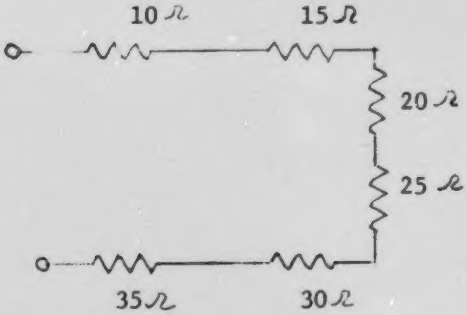


R_t = ____________________

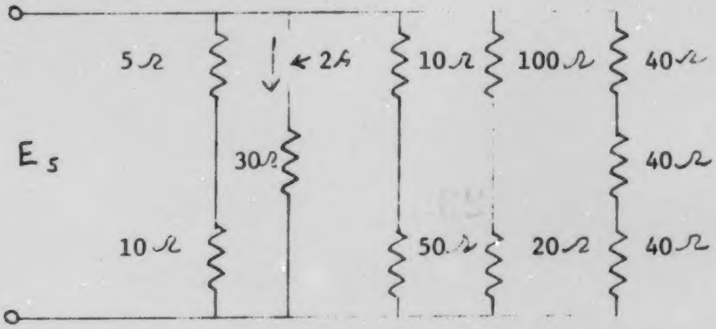


R_t = ____________________

E_s = ____________________



R_t = ____________________



R_t = ____________________

E_s = ____________________

NUMERATION

Rounding Numbers
Round numbers to any specific place value through one million.

Ten Millions	Millions	Hundred Thousands	Ten Thousands	Thousands	Hundreds	Tens	Ones
10,000,000	1,000,000	100,000	10,000	1,000	100	10	1

Answer These Questions:

1. **What is 4386 rounded to the nearest ten?**

A. 4280
B. 4380
C. 4390
D. 4400

2. **What is 643,849 rounded to the nearest thousand?**

A. 643,850
B. 643,800
C. 644,000
D. 640,000

3. **What is 9,675,000 rounded to the nearest hundred thousand?**

A. 9,670,000
B. 9,675,000
C. 9,680,000
D. 9,700,000

WHOLE NUMBER OPERATIONS

Add and subtract integers.

Solve These Problems:

4. 4326
9857
2015
+5634

A. 22,833
B. 21,832
C. 21,742
D. 21,732

5. 3804 + 527 + 96 + 12,485 = ____________

A. 16,912
B. 15,902
C. 15,911
D. 124,912

6. 512,705
-49,638

A. 463,169
B. 473,177
C. 463,067
D. 463,077

Multiply and divide integers.

Solve These Problems:

7. 836
x79

A. 56,044
B. 65,044
C. 66,046
D. 66,044

8. 987 x 456 = ______________

A. 440,172
B. 450,972
C. 450,182
D. 451,072

9. 6300 ÷ 97 = ______________

A. 64 92/97
B. 65 95/97
C. 65 85/97
D. 66

10. 1498 ÷ 49 = ______________

A. 3 28/49
B. 31
C. 32 30/49
D. 30 4/7

FRACTIONS AND OPERATIONS

Add and subtract fractions.

Add mixed numbers with unlike denominators.

Subtract mixed numbers with like denominators. (regrouping)

Subtract mixed numbers with unlike denominators. (no regrouping)

Solve These Problems:

11. 7 5/6
+2 3/6

A. 9 2/6
B. 10 1/3
C. 10 1/2
D. 10 8/6

12. 5 1/2 + 2 5/8 = ______________

A. 8 1/8
B. 7 6/10
C. 8 9/8
D. 7 6/16

13. 17 3/8
    -12 7/8

A. 4 6/8
B. 5 3/4
C. 4 1/2
D. 5 1/2

14. 9 2/3 - 5 1/4 = ____________________

A. 4 1/4
B. 4 11/12
C. 3 5/12
D. 4 5/12

Multiply fractions.

Multiply a mixed number by a proper fraction.

Multiply a whole number by a mixed number.

Multiply two mixed numbers.

Solve These Problems:

15. 5/6 x 426 = ________________________

A. 71
B. 210
C. 355
D. 356

16. 3 3/5 x 8/9 = ______________________

A. 24/15
B. 3 24/45
C. 3
D. 3 1/5

17. 12 x 8 3/4 = _____________________

A. 96 3/4
B. 105
C. 72
D. 100

18. 8 2/5 x 6 2/3 = ______________

A. 56
B. 48 4/15
C. 48 4/8
D. 46

Divide Fractions.

Divide a whole number by a proper fraction.

Divide a mixed number by a proper fraction.

Divide a mixed number by a mixed number.

Solve These Problems:

19. 15 ÷ 9/10 = ______________

A. 9 10/15
B. 10 9/15
C. 13 1/2
D. 16 2/3

20. 6 2/3 ÷ 4 = ______________

A. 1 1/12
B. 1 1/2
C. 1 2/3
D. 1 3/4

21. 8 2/3 ÷ 2/3 = ______________

A. 8
B. 13
C. 16 2/3
D. 17 1/3

22. 3 3/8 ÷ 2 1/4 = ______________

A. 1 1/2
B. 1 3/4
C. 2 3/8
D. 6 3/32

DECIMALS AND DECIMAL OPERATIONS

Convert fractions and decimals.

Change a common fraction to an equivalent decimal fraction.

Change a decimal fraction to an equivalent common fraction.

Solve These Problems:

23. Change 3/4 to a decimal.

A. 0.075
B. 0.75
C. 7.5
D. 75.0

24. Change 1/2 to a decimal.

A. 2.
B. 0.02
C. 0.2
D. 0.5

25. Change 0.3 to a fraction in lowest terms.

A. 3/100
B. 1/3
C. 3/10
D. 3

26. Change 0.07 to a fraction in lowest terms.

A. 7/100
B. 7/10
C. 1/7
D. 7

Add and subtract decimals.

Add decimals through thousandths.

Subtract decimals through thousandths.

Solve These Problems

27. 0.982 + 0.7 + 0.65 = ________________

    A. 1.054
    B. 1.117
    C. 2.332
    D. 9.117

28. 53.869 + 42.75 = ________________

    A. 95.944
    B. 96.619
    C. 58.144
    D. 95.619

29. 0.071 - 0.06 = ________________

    A. 0.065
    B. 0.067
    C. 0.076
    D. 0.011

30. 0.607 - 0.438 = ________________

    A. 0.231
    B. 0.169
    C. 0.179
    D. 0.279

Multiply decimals.

Multiply a whole number (limit: 3 digits) by a decimal (limit: thousandths).

Multiply a decimal by a decimal. (limit: thousandths).

Solve These Problems:

31. $\begin{array}{r} 0.695 \\ \underline{\times\ 86} \end{array}$

A. 0.5977
B. 5.977
C. 59.77
D. 58.97

32. 0.67 x 0.48 = ________________

A. 0.3226
B. 0.3216
C. 3.216
D. 32.16

33. 0.609 x 3.80 = ________________

A. 2.3142
B. 0.23142
C. 2.31402
D. 0.2314

34. $\begin{array}{r} 5.26 \\ \underline{\times 3.5} \end{array}$

A. 174.1
B. 184.10
C. 17.410
D. 18.41

Divide decimals.

Divide decimals. (limit: 5-digit dividends, 3-digit divisors).

Solve These Problems:

35. $25 \overline{)\,53.25}$

A. 0.23
B. 0.213
C. 2.013
D. 2.13

36. 8.001 - 0.7 = ____________________

A. 1.143
B. 10.43
C. 11.43
D. 114.3

37. 62.5 - 0.25 = ____________________

A. 25
B. 250
C. 205
D. 0.25

38. 2.193 - 0.215 = ________________

A. 1.20
B. 12
C. 10.2
D. 102

APPENDIX 6

FORMULAS AND CONVERSIONS

FORMULAS AND CONVERSION

Amplitude Conversion

$E_{p-p} = 2E_p \qquad E_p = \frac{E_{p-p}}{\text{[illegible]}}$

$E_p = 1.414\ E_{RMS} \qquad E_{RMS} = 707E_p$

$E_p = 1.57\ E_{AVE} \qquad E_{AVE} = .637E_p$

$E_{RMS} = 1.11\ E_{AVE} \qquad E_{AVE} = .9\ E_{RMS}$

These formulas may be used for current by substituting I for E.

Bandwidth

$$BW = \frac{fr}{Q}$$

Capacitance

$C = Q/V$

In series $C_T = \dfrac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$

In parallel $C_T = C_1 + C_2 + C_3 + \text{---}$

Capacitive Reactance

$$X_C = \frac{1}{2\pi fc}$$

In series $X_{CT} = X_{C_1} + X_{C_2} + X_{C_3} + \text{---}$

In parallel $X_{CT} = \dfrac{1}{\frac{1}{X_{C_1}} + \frac{1}{X_{C_2}} + \frac{1}{X_{C_3}} + \text{---}}$

Conductance

$$G = \frac{1}{R}$$

Current

$$I = \frac{Q}{T}$$

In impedance circuits $I = \dfrac{E_T}{Z} \qquad I = \sqrt{I_R^2 + (I_C - I_L)^2}$

Frequency-Period Conversions

$T = \frac{1}{f}$ $\qquad$ $f = \frac{1}{T}$

Impedance

$$Z = \frac{E_T}{I_T}$$

Series circuit $Z = \sqrt{R^2 + (X_L - X_C)^2}$ $\qquad$ $Z = \sqrt{R^2 + X_C^2}$

$Z = \sqrt{R^2 + X_L^2}$

Parallel circuit $Z = \frac{R\, X_L}{\sqrt{R^2 + X_L^2}}$ $\qquad$ $Z = \frac{R\, X_C}{\sqrt{R^2 + X_C^2}}$

$$Z = \frac{RX_L\ X_C}{\sqrt{(RX_L - RX_C)^2 + (X_L^2\ X_C^2)}}$$

Inductance: Induced voltage $E = L(\frac{\Delta i}{\Delta T})$

Quality $Q = \frac{X_L}{R}$

In series $L_T = L_1 + L_2 + L_3 \ldots$

In parallel $L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} \ldots}$

Inductive Reactance: $X_L = 2\pi fL$

In series $X_{LT} = X_{L1} + X_{L2} + X_{L3} \ldots$

In parallel $\frac{1}{\frac{1}{X_{L1}} + \frac{1}{X_{L2}} + \frac{1}{X_{L3}} \ldots}$

Ohms Law

$E = IR$ $\qquad$ $I = \frac{E}{R}$ $\qquad$ $R = \frac{E}{I}$

Parallel Circuits

$P_T = P_{R1} + P_{R2} + P_{R3} \cdots$

$R_T = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots}$

$E_T = E_{R1} = E_{R2} = E_{R3} \cdots$

$I_T = I_{R1} + I_{R2} + I_{R3} \cdots$

Power

$P = IE$ (direct current)

$P = I^2R \quad P = \dfrac{E^2}{R}$

$P = \dfrac{W}{T}$

$P_{app} = IE$ (Alternating Current)

$P = IE \cos\theta$

Power Factor

$PF = \cos\theta \qquad PF = \dfrac{P}{P_{app}}$

Quality (figure of merit) $Q = \dfrac{X}{R}$

Resistance

$R = \dfrac{\text{resistivity} \cdot \text{length}}{\text{area}}$

Resonant Frequency

$f_r = \dfrac{1}{2\pi\sqrt{LC}}$

Series Circuit

$P_T = P_1 + P_2 + P_3 \cdots$

$R_T = R_1 + R_2 + R_3 \cdots$

$E_T = E_{R1} + E_{R2} + E_{R3} \cdots$

$I_T = I_1 = I_2 = I_3 \cdots$

Time Constant

$$T = RC \qquad T = \frac{L}{R}$$

Transformers

$$\frac{N_{pri}}{N_{sec}} = \frac{E_{pri}}{E_{sec}} = \frac{I_{sec}}{I_{pri}}$$

$$\left(\frac{N_{pri}}{N_{sec}}\right)^2 = \frac{Z_{pri}}{Z_{sec}}$$

AC Voltage

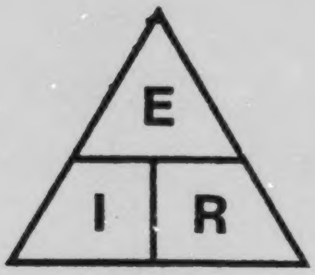
$$E = \frac{W}{Q}$$

$$E_T = I_T Z$$

Series circuit $E = \sqrt{E_R^2 + E_C^2}$ $\qquad E = \sqrt{E_R^2 + E_L^2}$

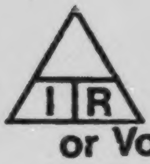
$$E = \sqrt{E_R^2 + (E_L - E_C)^2}$$

OHM'S LAW
IN THE
MAGIC TRIANGLE

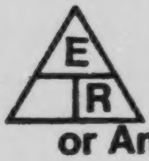


E = volts
I = amps
R = ohms

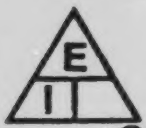
Three Formulas from Ohm's Law

A. E = 

or E = I x R
or Volts = Amps x Ohms

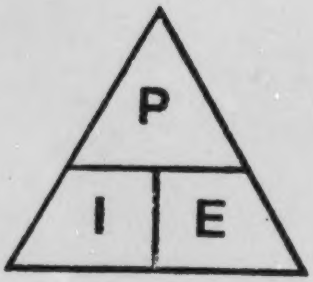
B. I = 

or I = E/R
or Amps = Volts ÷ Ohms

C. R = 

or R = E/I
or Ohms = Volts ÷ Amps

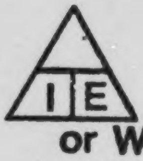
OHM'S LAW FOR POWER IN THE MAGIC TRIANGLE



P = Watts
I = Amps
E = Volts

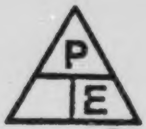
THREE FORMULAS FROM OHM'S LAW FOR POWER

A. P =



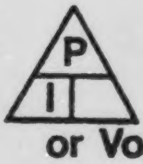
or P = I x E
or Watts = Amps x Volts

B. I =



or I = P/E
or Amps = Watts ÷ Volts

C. E =



or E = P/E
or Volts = Watts ÷ Amps

APPENDIX 7

OHM'S LAW AND POWER LAW WORKSHEETS

OHMS LAW
WORKSHEET I

Given two of the circuit parameters find the third.

Formula: E = I x R

1. E=10V I=0.015
2. E=50V R=5000 Ω
3. I=1.5A R=1.5K Ω
4. I=10A E=50V
5. E=6V R=50 Ω
6. E=120 I-14A
7. R=100K Ω I=5mA
8. R=2.2M Ω E=22KV
9. I=5.5A E=11KV
10. R=47K Ω I=10mA
11. I=16.6A R=.6 Ω
12. E=440 I=3A
13. E=37KV R=740K Ω
14. E=96V I=400mA
15. I=75mA R=47K Ω
16. R=100 Ω I=5A
17. R=390 Ω E=26V
18. I=.003A E=54V
19. I=45uA R=20M Ω
20. E=167V I=16.7A

POWER LAW WORKSHEET

Solve the following problems using the power law formulas.

1. E=120V I=3A
2. E=45V I=4A
3. I=5A E=1.6KV
4. E=34V I=50mA
5. E=60V I=35A
6. E=100V R=500 Ω
7. E=120V R=47K Ω
8. E=120V R=47 Ω
9. E=1200V R=2 Ω
10. I=2A R=8 Ω
11. I=16A R=2 Ω
12. I=35mA R=39K Ω
13. I=10 R=480 Ω
14. I=35ma R=12M Ω
15. I=14ma E=45kV

For the following problems solve for the indicated quantity.

16. I=6A P=360W E=____________
17. E=115V P=3450W I=____________
18. R=35K Ω E=50V I= ____________
19. E=64V P=320W I= ____________
20. R=34M Ω I=5uA E= ____________
21. E=120V I=300mA P= ____________
22. P=350W E=120V I= ____________
23. I=5A E=120V R= ____________
24. P=1250W I=10A E= ____________
25. P=64W R=4 Ω I= ____________

Name ______________________________

Date ______________________________

Ohm's Law

1. I=10A R=27Ω E= ____________________

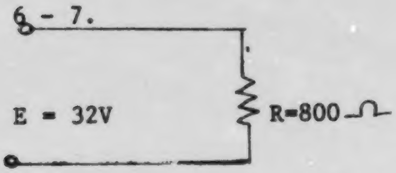
2. E=110V I=.02A R= ____________________

3. E=20V I=5A P= ____________________

4. E=110V R=2000Ω I= ____________________

5. P=120W I=2A E= ____________________

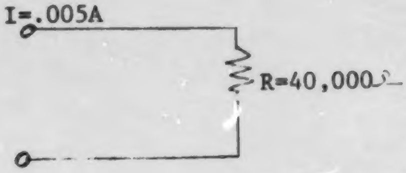
6 - 7.



I= + ______________________

P= ______________________

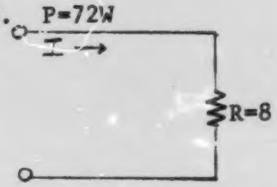
8 - 9.



E= ______________________

P= ______________________

10.

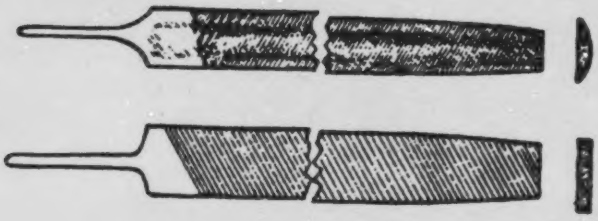


I= ____________________

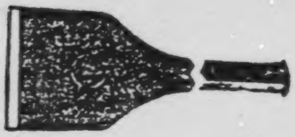
APPENDIX 8

IDENTIFICATION OF TOOLS

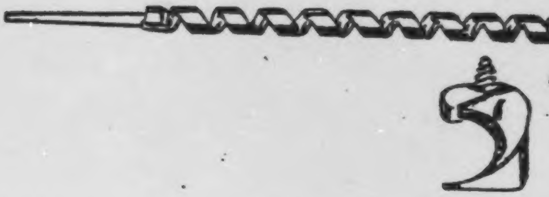
Tools and Equipment



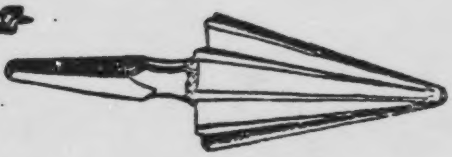
FILE (SINGLE & DOUBLE CUT)



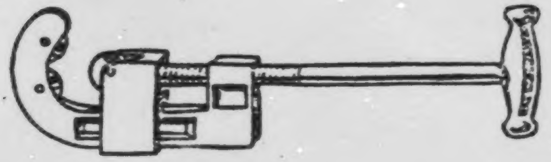
CHISEL



POWER AUGER

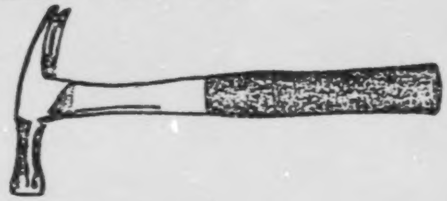


REAMER

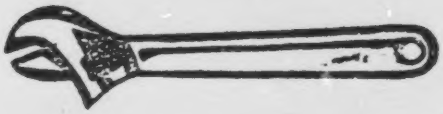


PIPE CUTTER

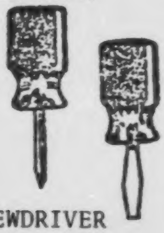
ELECTRICIAN HAMMER



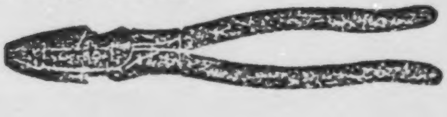
ADJUSTABLE WRENCH



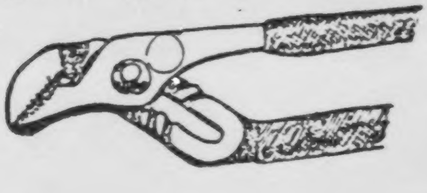
STUBBY SCREWDRIVER



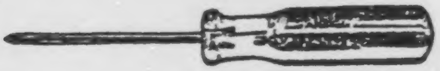
LINEMAN PLIERS



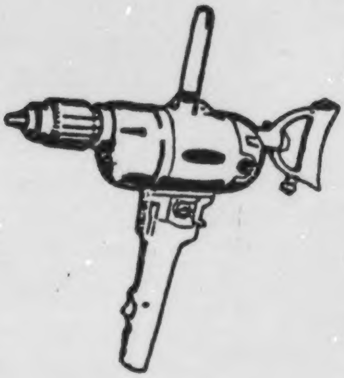
GROOVE JOINT PLIERS



PHILIPS SCREWDRIVER



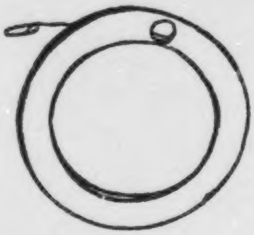
BRACE



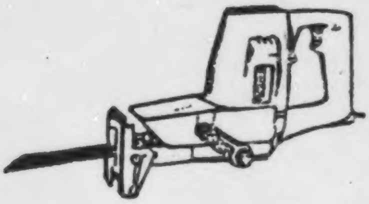
DRILL MOTOR

KNOCK OUT PUNCHES

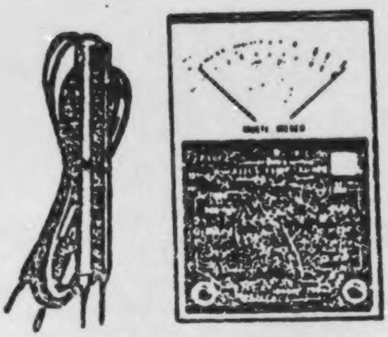
KEY HOLE SAW



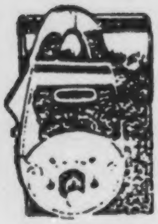
FISH TAPE



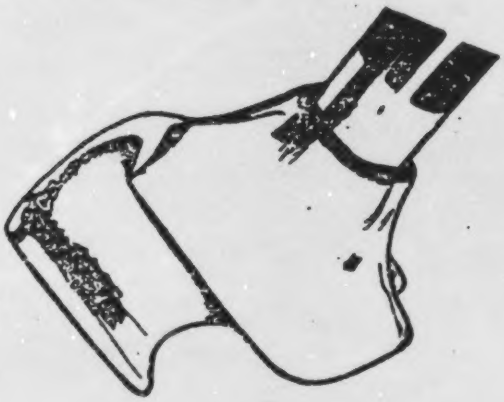
RECIPROCAL SAW



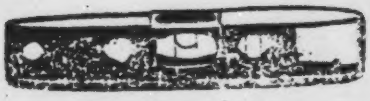
VOLG-OHMMETER



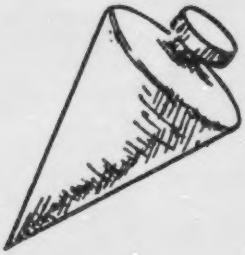
CLAMP AMMETER



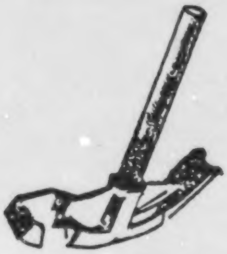
HICKEY



LEVER (TORPEDO)

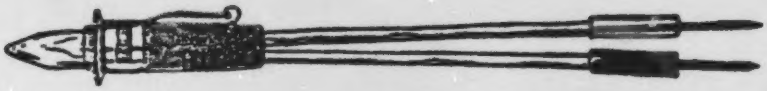


PLUMB BOB

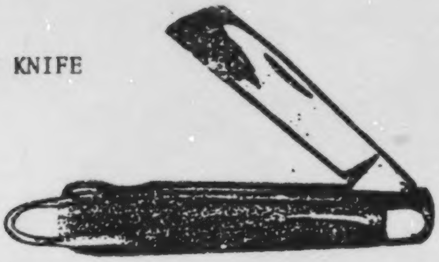


CONDUIT BENDER

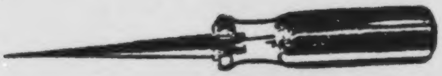
____ NEON TESTER LIGHT



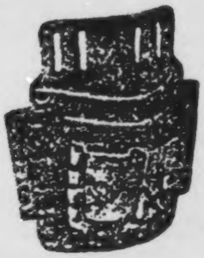
____ POCKET KNIFE



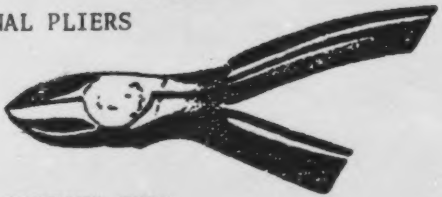
____ AWL



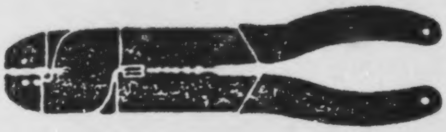
____ TOOL POUCH



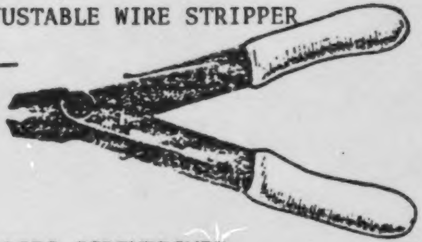
____ DIAGONAL PLIERS



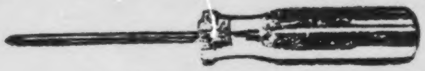
____ MULTI-PURPOSE TOOL



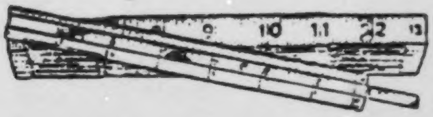
____ ADJUSTABLE WIRE STRIPPER



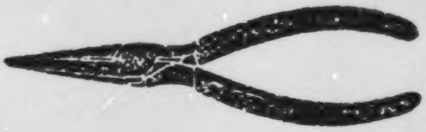
____ PHILIPS SCREWDRIVER



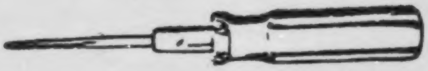
____ FOLDING RULE



____ LONG NOSE PLIERS



____ TAPPLING TOOL



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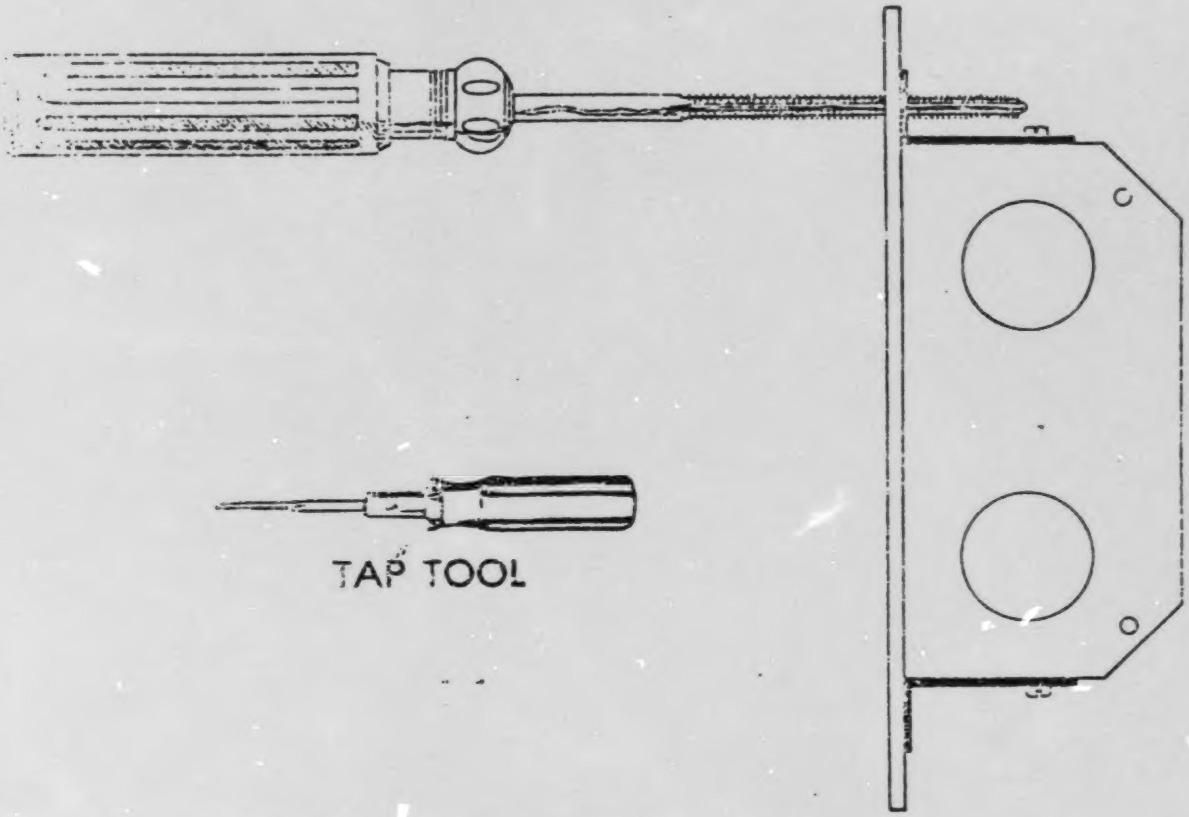
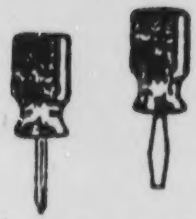
TAP TOOL

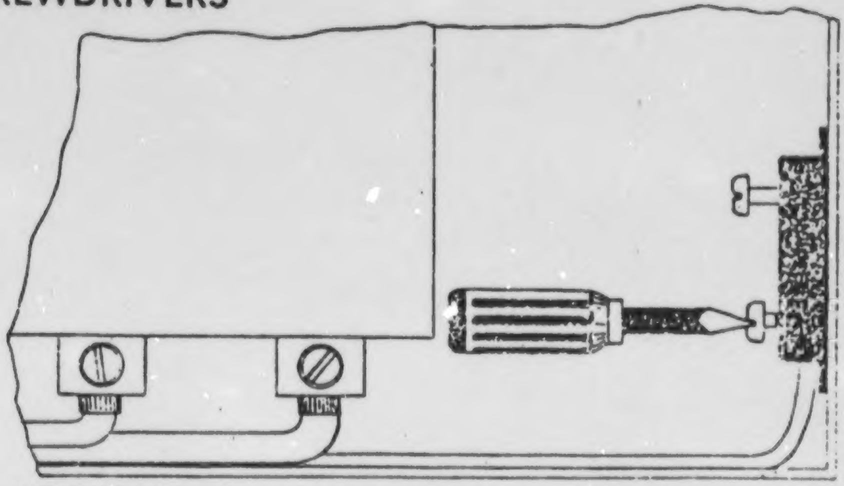
RETAPPING DAMAGED THREADS



TAP TOOL

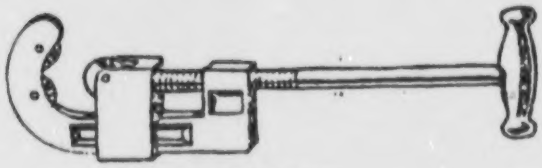


STUBBY SCREWDRIVERS



STUBBY SCREWDRIVER

TIGHTENING A LUG IN LIMITED WORKING SPACE



PIPE CUTTER

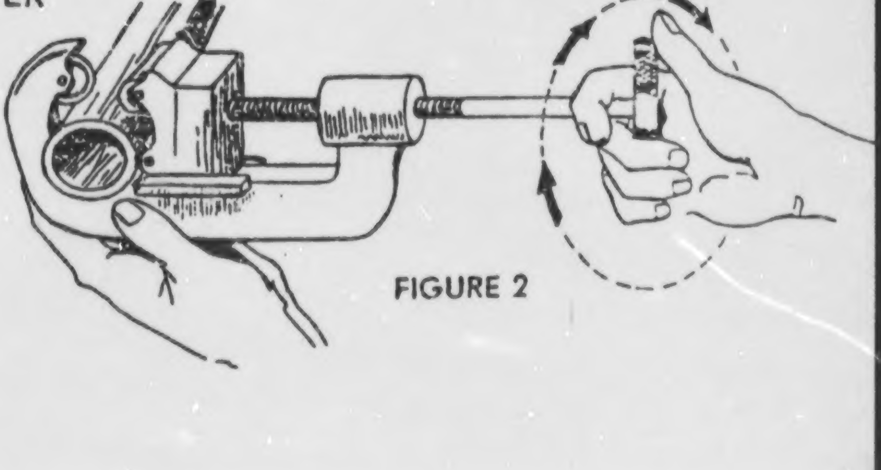
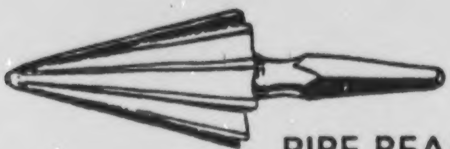


FIGURE 2



PIPE REAMER

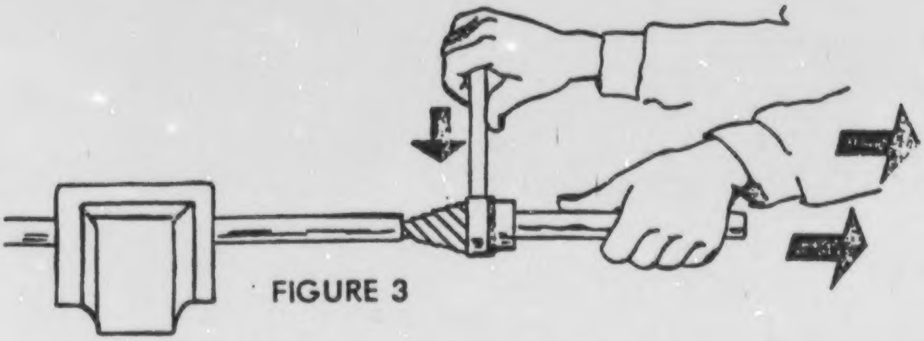
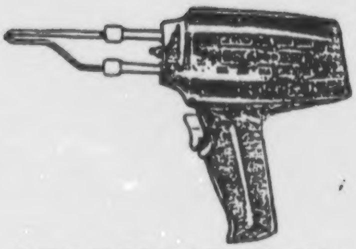
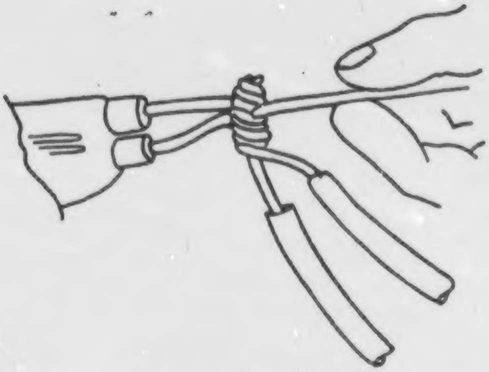


FIGURE 3



SOLDERING GUN



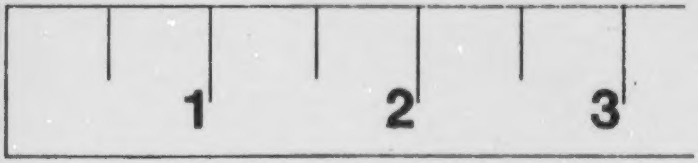
SOLDERING TWO WIRES TOGETHER

APPENDIX 9

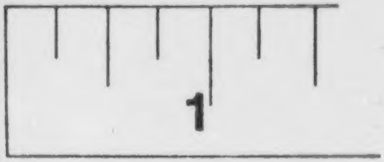
GRADUATIONS OF A RULE

Graduations on a Rule

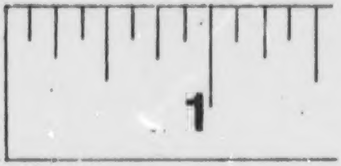
Halves



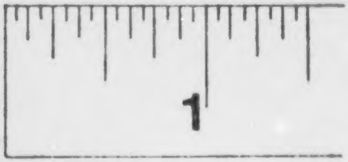
Quarters



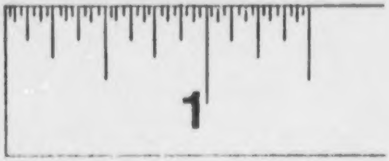
Eighths

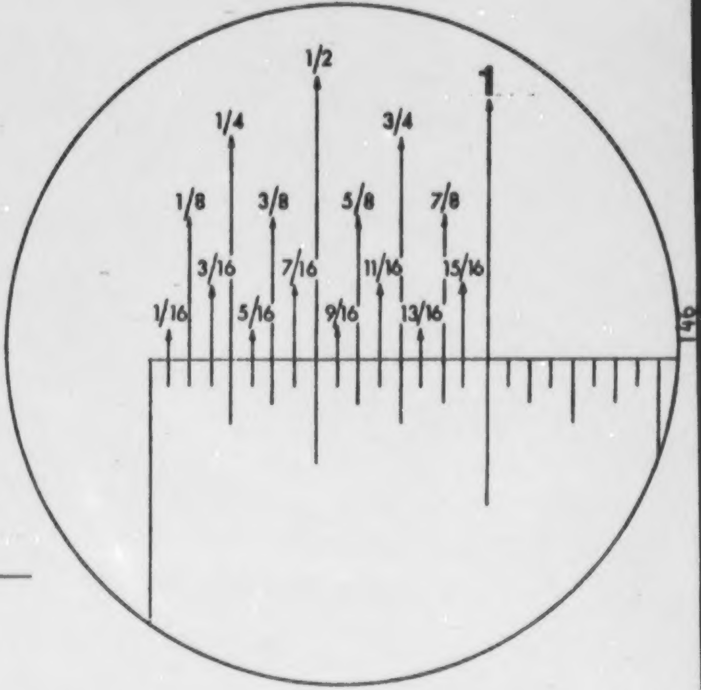


Sixteenths



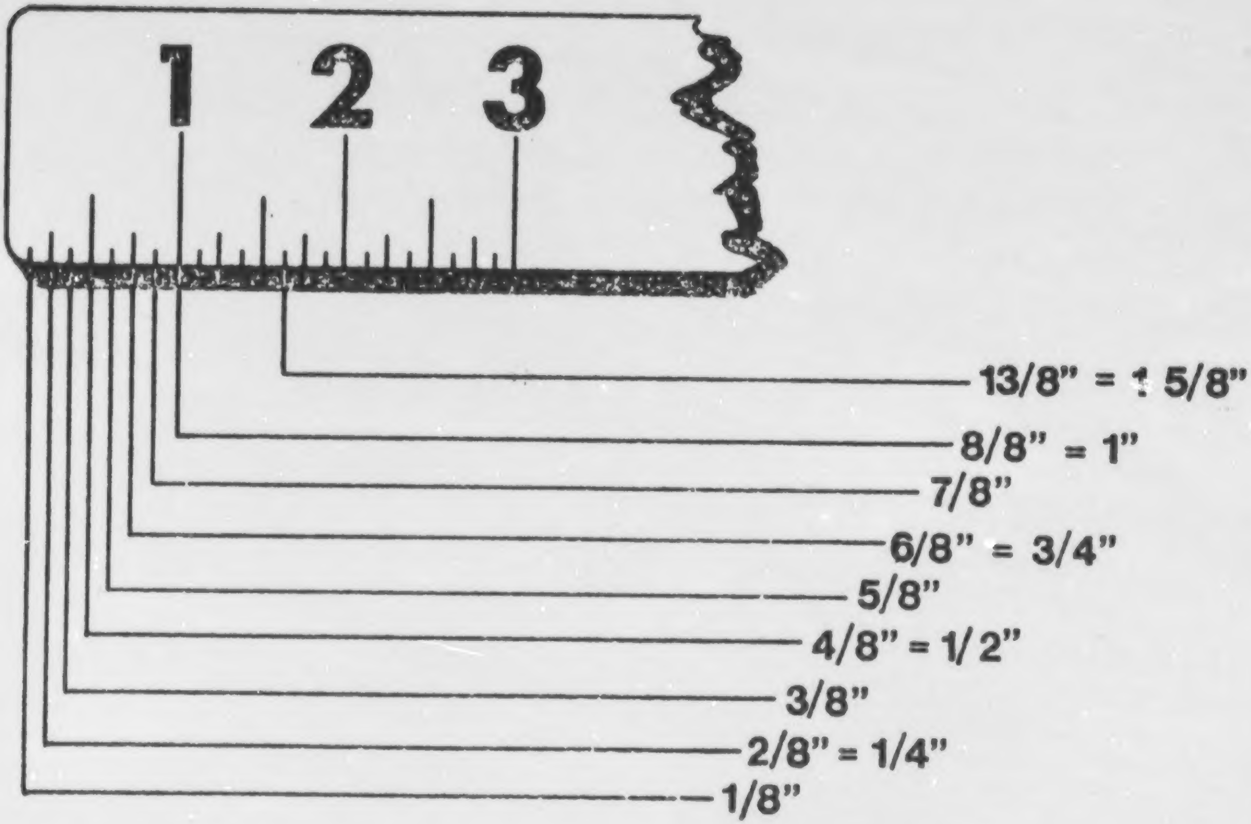
Thirty-seconds



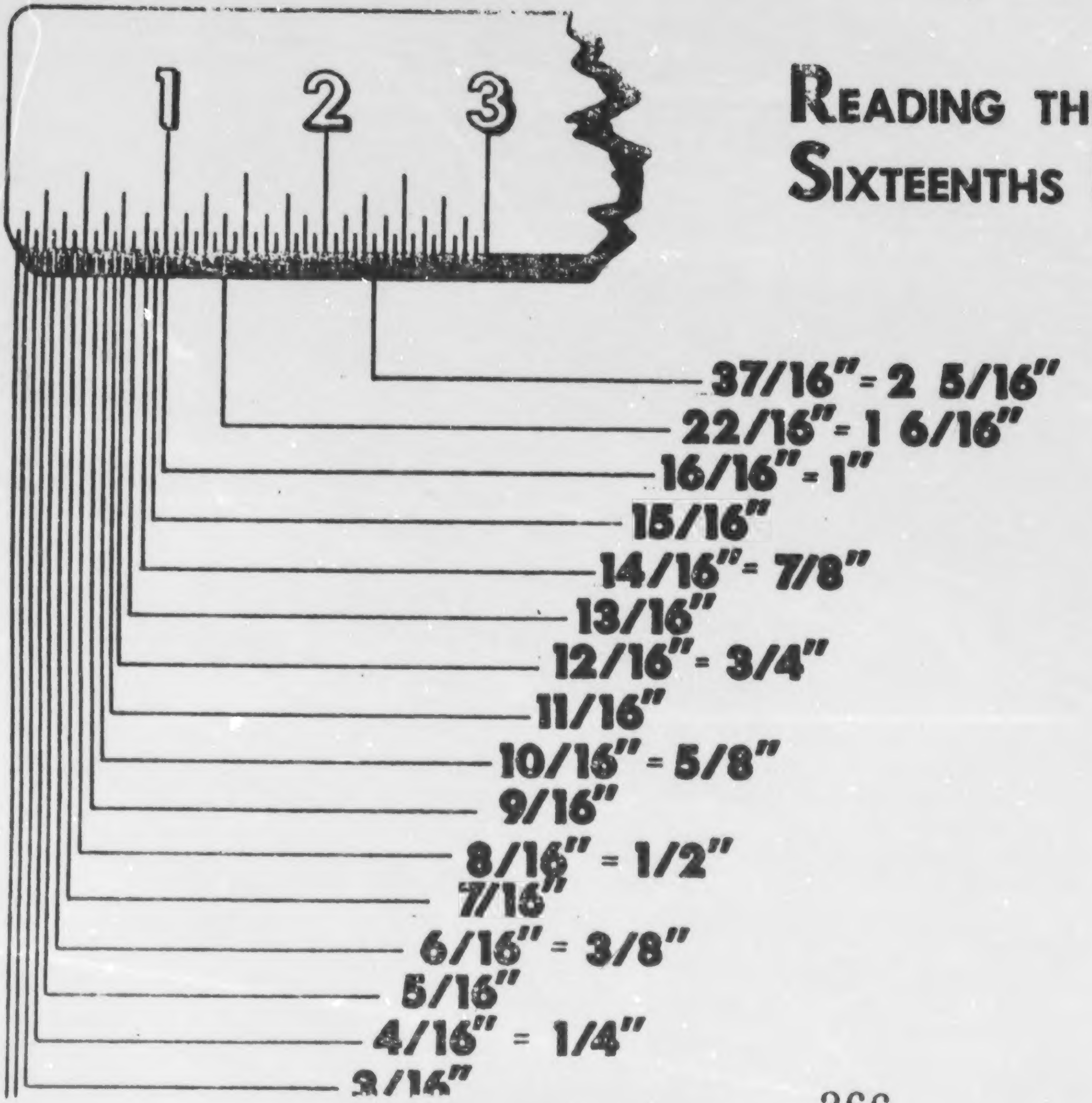


Graduations Applied to a Rule

READING THE EIGHTHS RULE

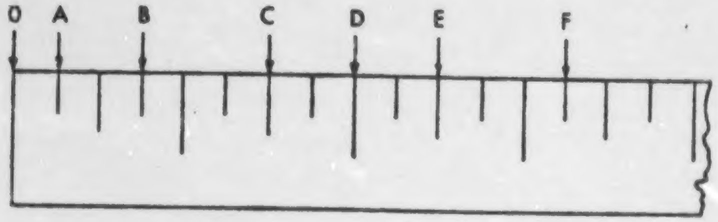


READING THE SIXTEENTHS RULE



Study Question:

1. Use the drawing below and read the rule to the nearest one-fourth inch.



A. 0-A ________

B. 0-B ________

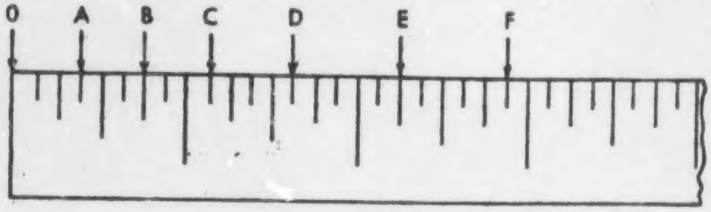
C. 0-C ________

D. 0-D ________

E. 0-E ________

F. 0-F ________

2. Use the drawing below and read the rule to the nearest one-eighth inch.



A. 0-A ________

B. 0-B ________

C. 0-C ________

D. 0-D ________

E. 0-E ________

F. 0-F ________

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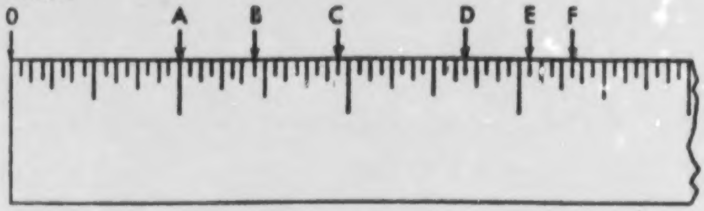
3. Use the drawing below and read the rule to the nearest one-sixteenth inch.



A. 0-A ____________

B. 0-B ____________

C. 0-C ____________

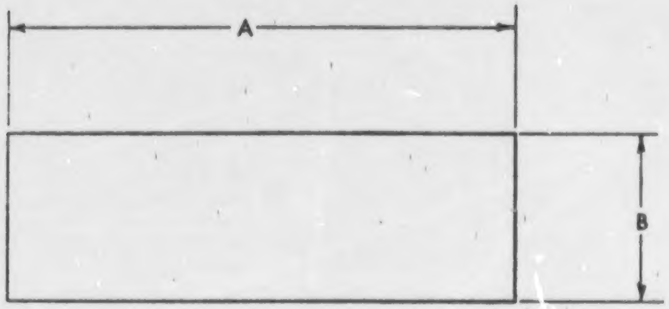
D. 0-D ____________

E. 0-E ____________

F. 0-F ____________

Using a rule with one-sixteenth inch graduations, measure the following objects. Convert each of the measurements to the actual size of the object. (Have instructor explain scale.)

4.



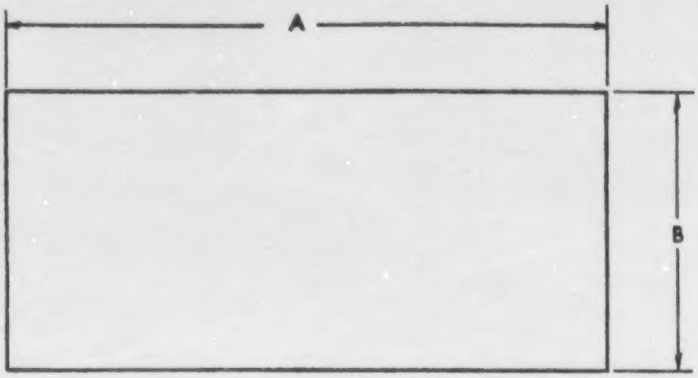
Scale 1/8" = 1'

A. Length ____________

B. Height ____________

Study Questions: Continued

5.

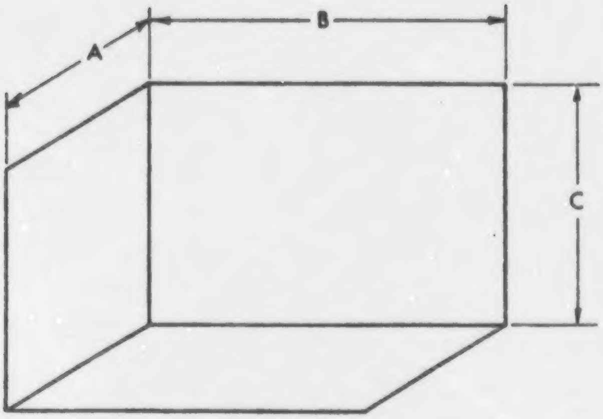


1'' = 20'

A. Length ____________

B. Height ____________

6.



¼'' = 5'

A. Width ____________

B. Length ____________

C. Height ____________

APPENDIX 10

HOUSEWIRING MATERIALS

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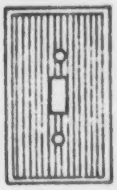
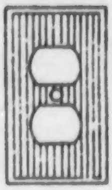
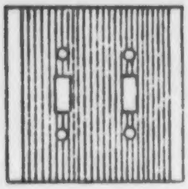
WALL PLATES



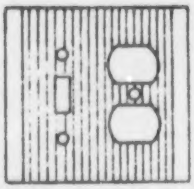
SINGLE TOGGLE



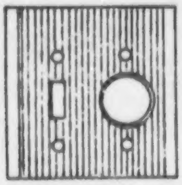
DUPLEX RECEPTACLE



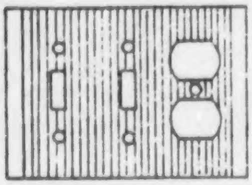
TWO TOGGLE



SINGLE TOGGLE AND DUPLEX RECEPTACLE

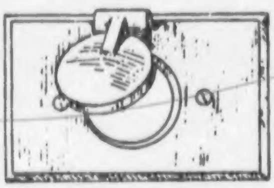


SINGLE TOGGLE AND SINGLE RECEPTACLE

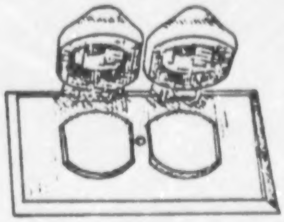


TWO TOGGLE AND DUPLEX RECEPTACLE

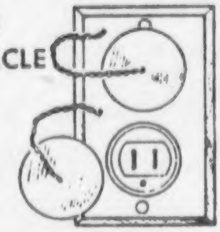
WEATHERPROOF SINGLE RECEPTACLE

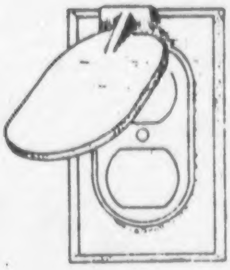


WEATHERPROOF DUPLEX RECEPTACLE (HORIZONTAL)



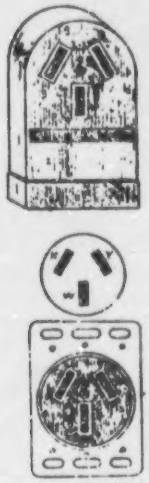
WEATHERPROOF DUPLEX RECEPTACLE WITH SCREW COVERS



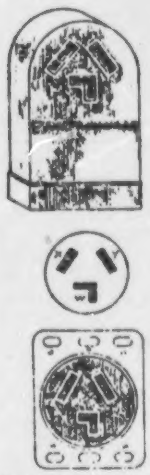


WEATHERPROOF DUPLEX RECEPTACLE (VERTICAL)

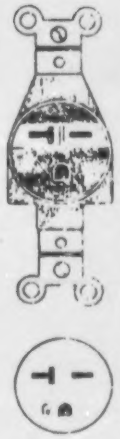
COMMON RESIDENTIAL RECEPTACLES



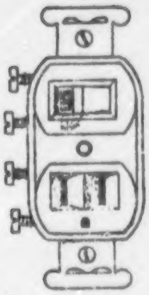
RANGE RECEPTACLE
125/250v, 50 amp



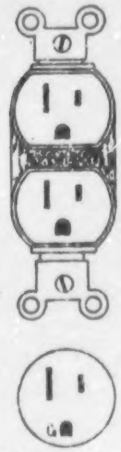
DRYER RECEPTACLE
125/250v, 30 amp



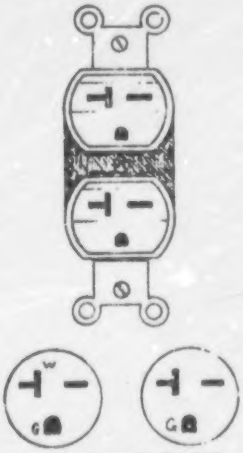
AIR CONDITIONER RECEPTACLE
250v, 20 amps



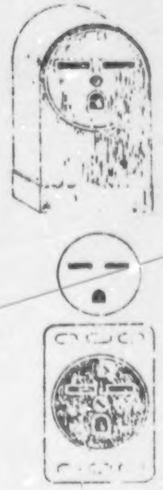
SWITCH AND RECEPTACLE



DUPLEX GROUNDING RECEPTACLE
125v, 15 amp



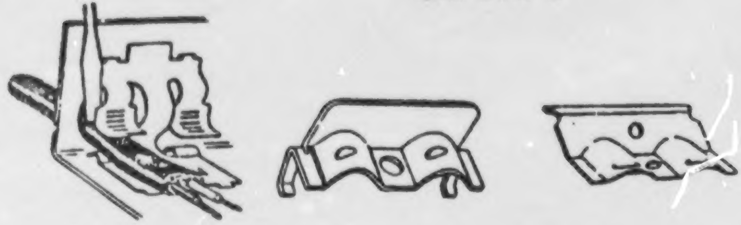
DUAL VOLTAGE RECEPTACLE
125/250v, 20 amp



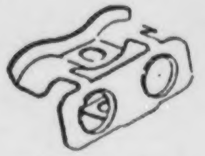
AIR CONDITIONING RECEPTACLE
250 volt, 30 amp

BOX DESIGN FEATURES

CLAMPS

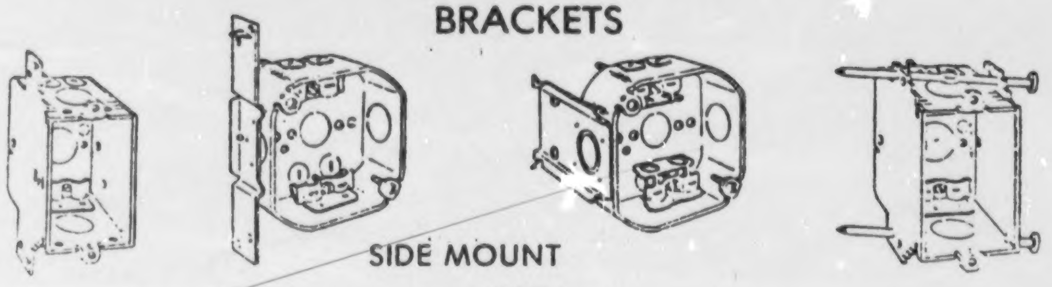


NONMETALLIC CABLE CLAMPS

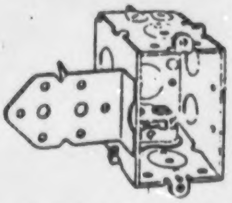


METALLIC
CABLE CLAMP

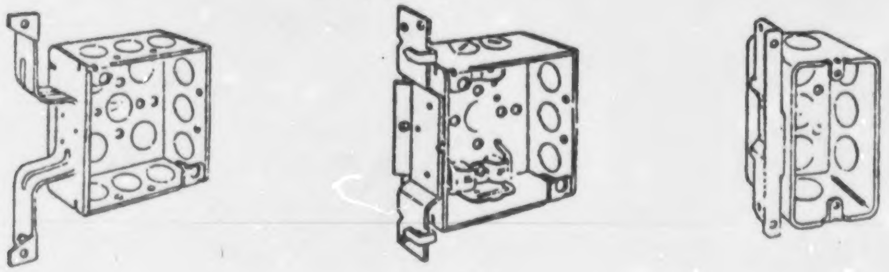
BRACKETS



SIDE MOUNT



FRONT MOUNT

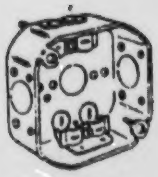


SIDE AND FRONT MOUNT

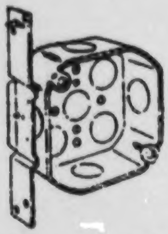
Continued

OCTAGON AND SQUARE BOXES

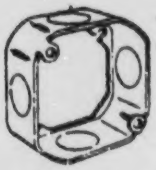
OCTAGON BOXES



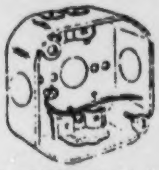
WITH CABLE CLAMPS
AND NAIL HOLES



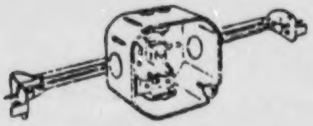
WITH BRACKET



EXTENSION

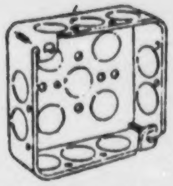


WITH CABLE CLAMPS
AND GROUNDING PIGTAIL

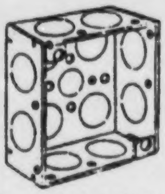


WITH BAR HANGER
AND CABLE CLAMPS

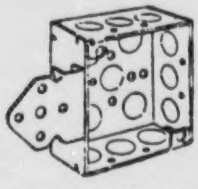
SQUARE BOXES



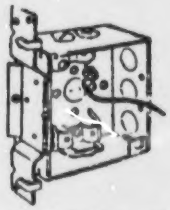
SQUARE BOX (ONE PIECE
MOLDED CONSTRUCTION)



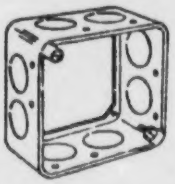
SQUARE BOX (ONE PIECE
WELDED CONSTRUCTION)



WITH BRACKET



WITH BRACKET, CABLE CLAMPS
AND GROUNDING PIGTAIL

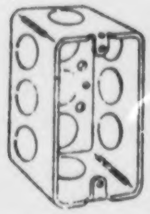


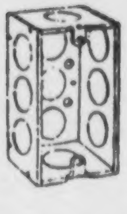
EXTENSION

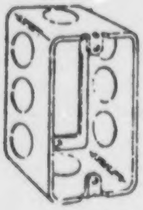
Fig. 1
Continued

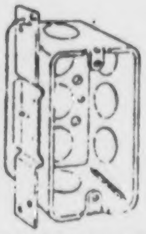
DEVICE BOXES

HANDY BOXES

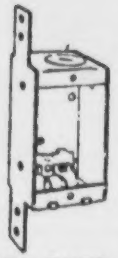

HANDY BOX
(MOLDED
CONSTRUCTION)

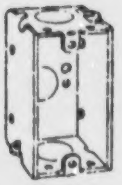

HANDY BOX
(WELDED
CONSTRUCTION)

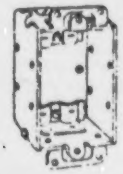

EXTENSION

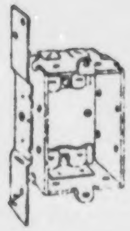

BRACKET BOX

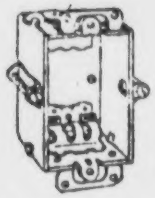
SWITCH BOXES

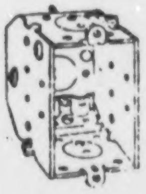

BRACKET
NON-GANGABLE
WITH
CABLE CLAMPS

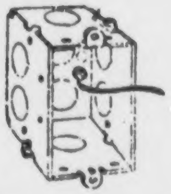

GANGABLE
WITH
NAIL HOLES

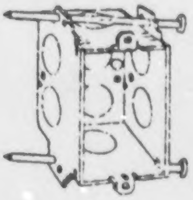

GANGABLE
WITH
EARS AND
CABLE CLAMPS

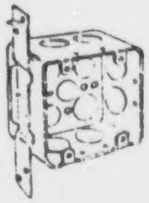

GANGABLE
BRACKET BOX
WITH
CABLE CLAMPS


WITH
DRYWALL GRIPS,
CABLE CLAMPS
AND EARS


BEVELED
CORNER
WITH
CLAMPS

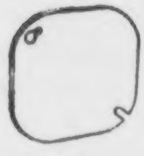

GANGABLE
WITH
GROUNDING
PIGTAIL

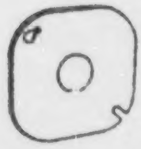

NAIL ON

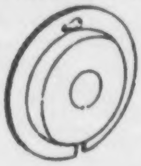

SOLID
TWO GANG
BRACKET

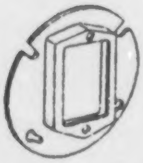
BOX COVERS

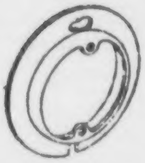
ROUND COVERS

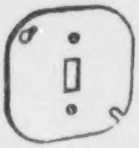

FLAT
BLANK

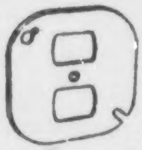

FLAT WITH
KNOCKOUT

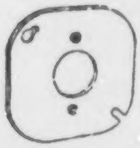

RAISED WITH
KNOCKOUT


RAISED FOR
SINGLE DEVICE

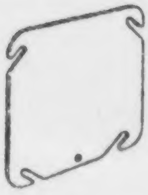

RAISED
OPEN

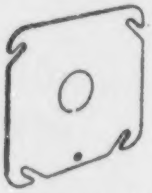

FLAT
TOGGLE

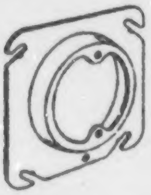

FLAT DUPLEX
RECEPTACLE

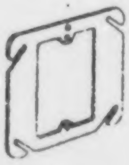

FLAT SINGLE
RECEPTACLE

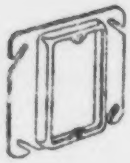
SQUARE COVERS

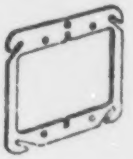

FLAT BLANK

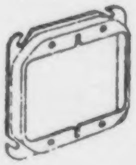

FLAT BLANK
WITH
KNOCKOUT


RAISED OPEN


FLAT
SINGLE DEVICE

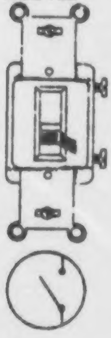

RAISED
SINGLE DEVICE


FLAT
TWO DEVICE

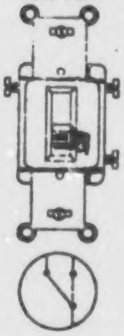

RAISED
TWO DEVICE

SWITCHES

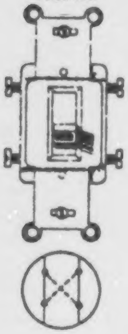
SINGLE POLE



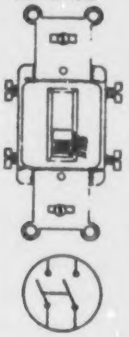
THREE WAY



FOUR WAY



DOUBLE POLE



DIMMER

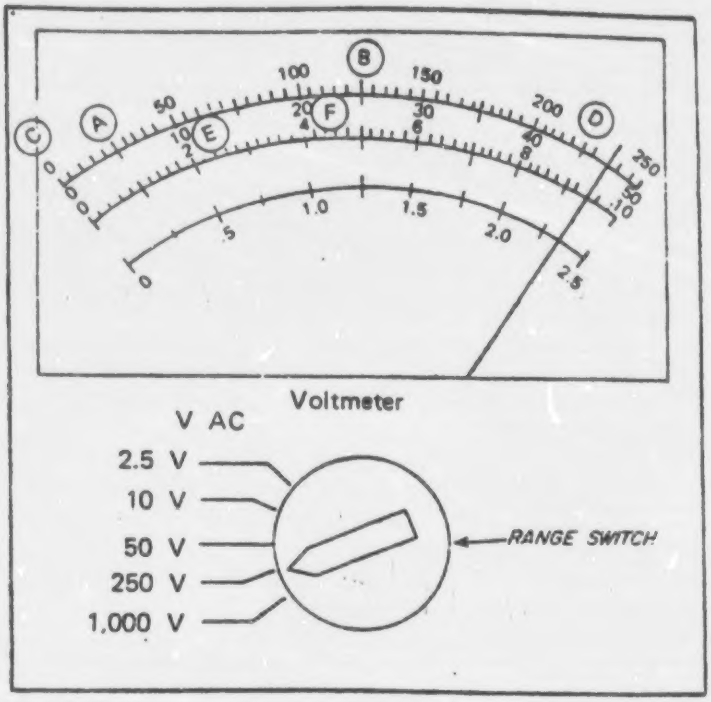
LOW VOLTAGE
PUSH BUTTON

APPENDIX 11

READING METERS

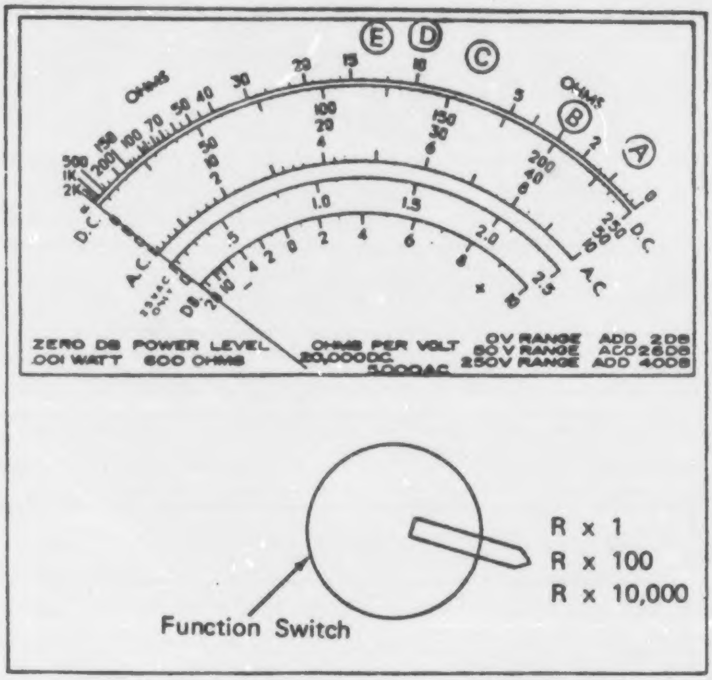
278

This voltmeter will read from left to right on the scale.



1. With the range switch at 250V, the needle on the meter is indicating 235V.
2. Range switch in the 250V position. Needle is pointing to "B" on the scale. The meter is indicating 125V.
3. Range switch in the 50V position. Needle is pointing to "B" on the scale. The meter is indicating 25V.
4. Range switch in the 1000V position. (NOTE: Use the 0-10 scale when in the 1000V position.) Since 1000 is 100 times greater than 10, multiply any reading taken from the 0-10 scale by 100. Needle is pointing to "E" on the scale. The meter is indicating 2.4V x 100 = 240V.
5. Range switch in the 250V position. Needle is pointing to "A" on the scale. The meter is indicating 25V. (The reading would be more accurate if the range switch were changed to 0-50V.)
6. Range switch in the 250V position. Needle is pointing to "C" on the scale. The meter is indicating 0V. (The range switch should be switched in the direction of the lowest range until the proper range is reached.)

Read the resistances on the ohmmeter scale below. This ohmmeter scale reads from right to left.

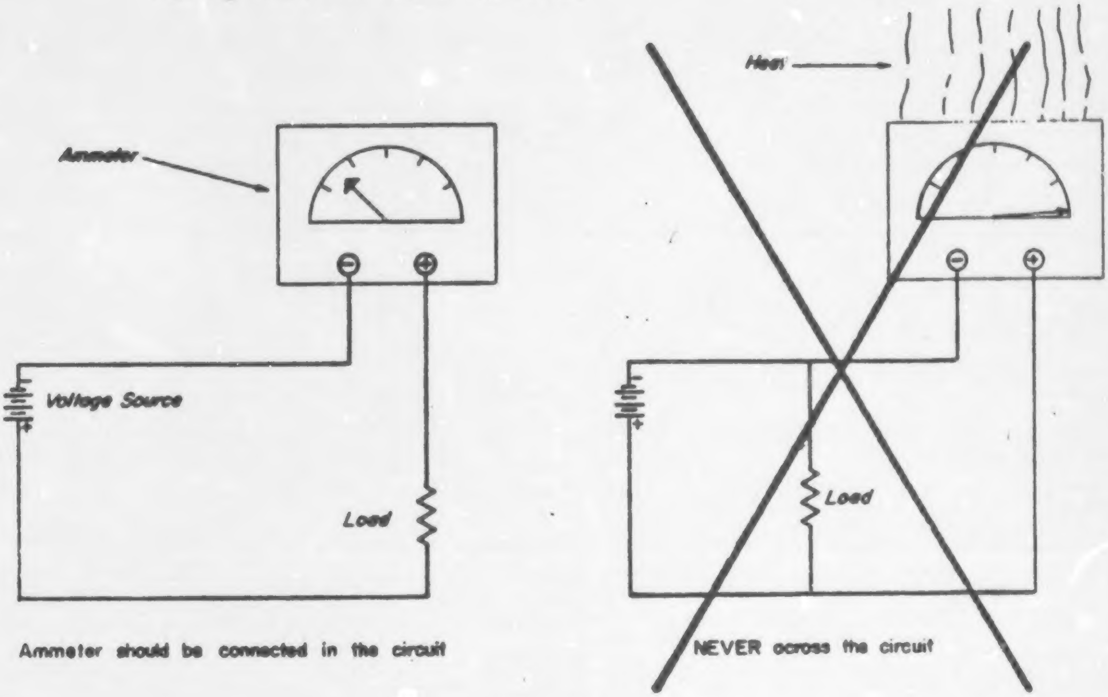


(NOTE: The letters on the scale are there for the purpose of working this exercise and they do not appear on actual ohmmeters.)

Example: With the function switch at R x 10,000 and the needle pointing at 2 on the scale

$$\begin{array}{r} 10{,}000 \\ \underline{\times \quad 2} \\ 20{,}000 \end{array} \text{ ohms}$$

Using the Ammeter in a Circuit



Ammeter should be connected in the circuit

NEVER across the circuit

Fig. 1

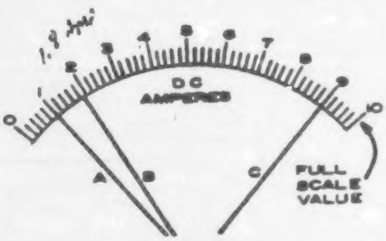
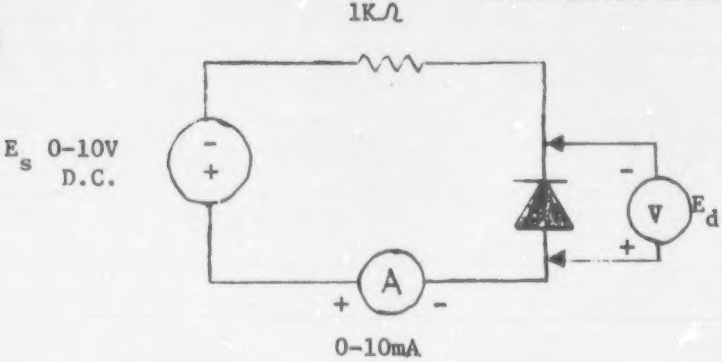


Fig. 2

APPENDIX 12

SAMPLE LAB EXERCISES

DIODE CHARACTERISTICS



MATERIALS

1 KΩ resistor
1 N4001 diode
0-10 mA Ammeter
0-50 uA Ammeter
Volt ohmmeter
VTVM or electronic voltmeter
Variable Power Supply

1. Construct the circuit shown in the schematic diagram. Begin by adjusting E_s to 0.2V. Record E_d and current in chart. Complete chart at values indicated.

E_s	0.2	0.5	0.7	1.0	2.0	3.0	4.0	5.0	10.0
E_d									
I									

Is diode forward biased or reverse biased?________________________

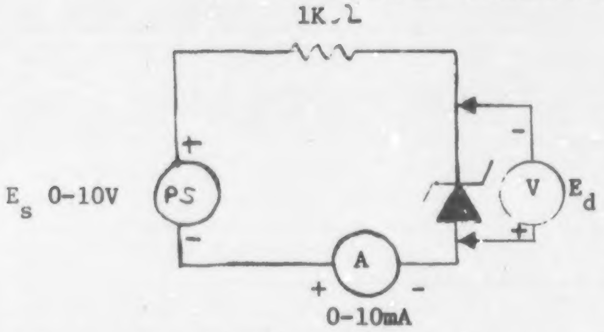
2. Reduce voltage to zero. Reverse diode connections and replace the 0-10 mA ammeter with a 0-5- uA ammeter. Repeat the measurements from step 1.

E_s	0.2	0.5	0.7	1.0	2.0	3.0	4.0	5.0	10.0
E_d									
I									

Is diode forward biased or reverse biased?________________________

Using graph paper graph the volt-ampere characteristics of the diode (I vs E_d). Remember that at $E_d = 0$, $I = 0$.

ZENER DIODE CHARACTERISTICS



Materials

1 K Ω Resistor
Zener diode 6.8 V
0-10 mA Ammeter
0-50 uA Ammeter
VTVM or Electronic Voltmeter
Volt ohmmeter
Variable Power Supply

1. Construct the circuit shown in the schematic above. Be sure to check the polarity of the meters. Adjust E_S to 0.2V. Record diode voltage E_d, and Current, I, in chart below. Continue for each value of E_S indicated.

E_S	0.5	1.0	2.0	3.0	5.0	6.0	7.0	8.0	10.0
E_d									
I									

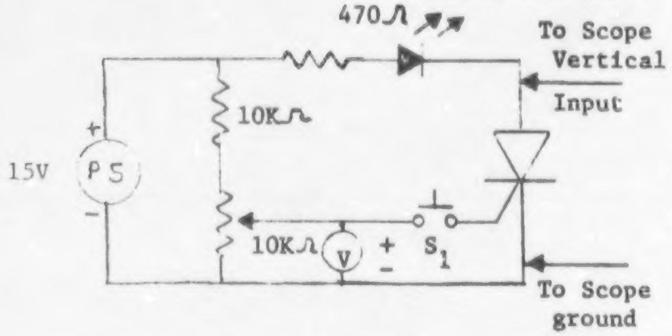
Compare your results with the forward bias results from the diode characteristics lab.

2. Reduce the voltage to zero. Reverse the diode connections. Replace the 0-10 mA ammeter with the 0-50 uA ammeter. Repeat the measurement taken in Step 1. NOTE: At some voltage level the 0-50 uA ammeter may need to be replaced by the 0-10 mA. At this point be sure and reduce power to zero before making changes in the circuit.

E_S	0.5	1.0	2.0	3.0	5.0	6.0	7.0	8.0	10.0
E_d									
I									

Using graph paper graph the volt-ampere characteristics of the diode (I vs E_d)

SCR CHARACTERISTICS



Materials

470Ω Resistor
10KΩ Resistor
10KΩ Potentiometer-linear
PBNO Switch
GE106B1 S.C.R.
Red LED
VTVM
Oscilloscope

1. Construct the circuit shown in the schematic diagram. Adjust 10KΩ pot to the middle range. Apply 15 V DC in the polarity indicated. Did the LED light? ____________ Why? ____________________
Close switch S_1. What happened? Why? ____________________
____
Release S_1. What happened? Why? ____________________
2. Reduce voltage to zero. Reverse the connections of the power supply and the diode. Reapply the 15V. What happened? ____________________
Close S_1. Did the LED light? Why? ____________________
3. Reduce voltage and return power supply and diode connections to normal (step 1). Connect VTVM from ground to potentiometer as shown. Adjust to zero volts with meter on the 1 volt scale. Connect jumper wire across S_1 terminals. Slowly turn potentiometer until LED lights. Record VTVM reading. ____________
This voltage is referred to as turn on voltage. Readjust potentiometer to midpoint and reduce supply voltage to zero. Remove jumper from S_1. Remove VTVM.
4. Replace the 15V D.C. supply with 15V A.C. supply. Apply voltage and depress S_1. What happened? ____________________
Release S_1. What happened? Why? ____________________
____
5. Reduce supply to zero. Connect oscilloscope as shown in schematic. Replace jumper on S_1 terminals. Apply voltage. LED should be lighted. Adjust potentiometer for maximum brightness of LED. Using oscilloscope, measure peak voltage of waveform. ____________________

Sketch the scope display.

Readjust potentiometer to middle position. Has waveform changed? How?
____________ Reduce potentiometer for minimum LED brightness.
Measure peak voltage of waveform ____________________

Sketch the scope display.

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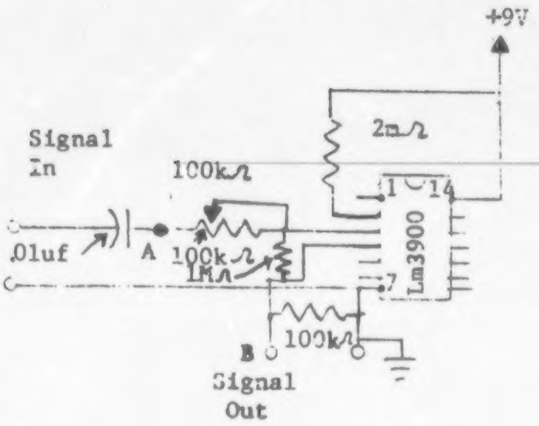
I.C. AMPLIFIER



Materials

LM3900N Quad op Amp I.C.
2 100 KΩ Resistor
100 KΩ potentiometer
1 MΩ Resistor
2 MΩ Resistor
0.01 uf capacitor
1 MΩ potentiometer
Breadboard
Signal generator
Oscilloscope
Power supply

1. Construct the circuit shown. Using oscilloscope, adjust output of the signal generator to 0.5V peak-to-peak at 1000 HZ. Adjust potentiometer for minimum resistance. Apply signal to input and power to chip.

2. Using oscilloscope measure the voltage at points A and B.

   E_A = ____________________ E_B = ____________________

   Determine voltage gain ($\frac{E_B}{E_A}$)= ____________________ Is the signal at E_B in phase or inverted as compared to E_A?

   ____

3. Adjust potentiometer to midrange. Repeat measurements from step 2.
   E_A = ____________________ E_B = ________________ E_{Gain}= ________________

4. Adjust potentiometer to maximum resistance. Repeat the measurements from step 2.

   E_A = ____________________ E_B= ________________ E_{Gain}= ________________

5. Remove power. Replace the 100KΩ potentiometer with the 1 MΩ potentiometer. Apply power. Adjust for maximum voltage output. E_B = __________ Determine gain. E_{gain} = ____________________. Adjust potentiometer for minimum output. Determine gain. ________________ What can you conclude about the effects of the MΩ potentiometer on the gain of the circuit?____________________________

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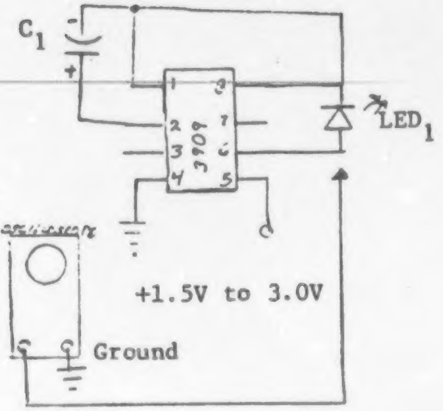
L.E.D. FLASHER



Probe

I.C.$_1$ 3909 LED Oscillator Chip

C$_1$ 35 to 50 uf electrolytic, 10V

LED$_1$ Red Light Emitting Diode

Power supply or 1.5 V battery
Hook-up wire
Breadboard

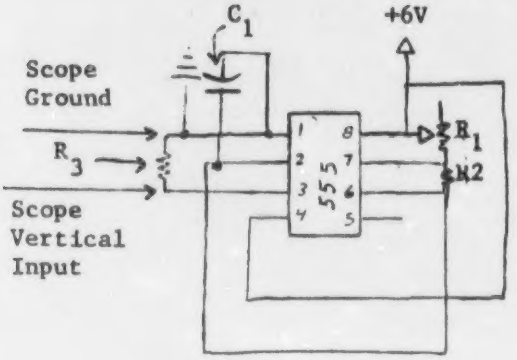
1. Connect circuit as indicated in schematic diagram. Note that pins 3 and 7 are not connected. Upon applying power LED should flash at a rate of approximately 6 Hertz.

2. Connect oscilloscope as shown to display output waveform. Sketch the wave form.

3. Using the oscilloscope measure the peak voltage. ______________________

4. Disconnect the circuit from power. Remove the connection from Pin 1 to Capacitor C$_1$. Be sure pin 8 is still connected to Capacitor C$_1$. Reconnect the power. Has the output changed?______________________ How?______________

SQUARE WAVE GENERATOR



R_1 500kΩ potiometer
R_2, R_3 1 KΩ
C_1 .01 uf
I.C.$_1$ NE555 Timer Chip
6 volt battery
Breadboard
Hook-up Wire

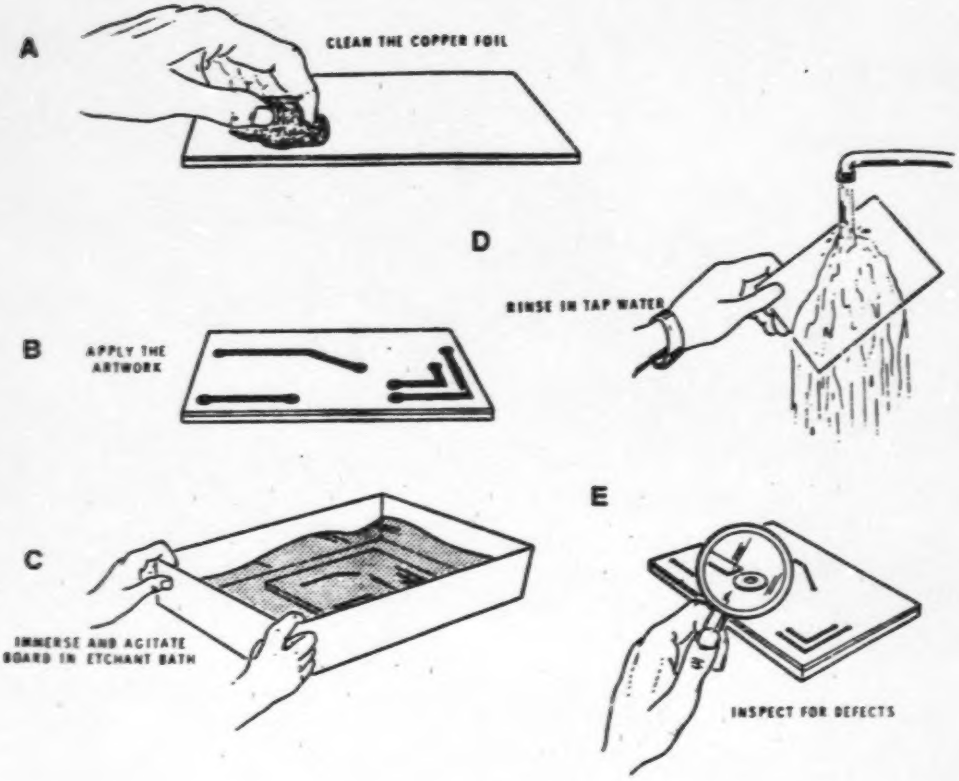
1. Construct the circuit as shown in the schematic diagram. Note that Pin 5 is not connected and that pin 3 is the output. R_3 is acting as a load.

2. Adjust R_1 for maximum resistance using ohmmeter. Connect oscilloscope to R_3 as shown. Apply power to the circuit.

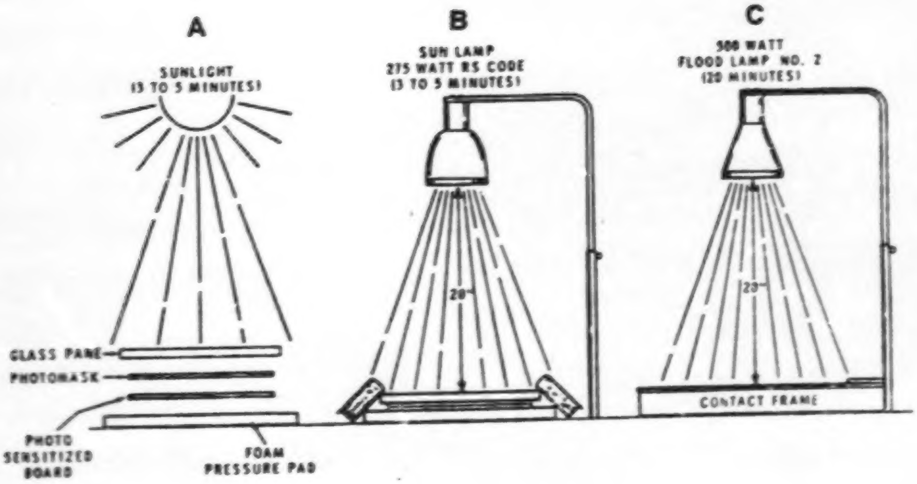
3. Sketch the output waveform.
   What is the peak voltage? ______________________
   Decrease the resistance of R_1. What effect does this have on the frequency?
   Why?

APPENDIX 13

PRINTED CIRCUIT BOARD CONSTRUCTIONS



Direct pattern etching process.



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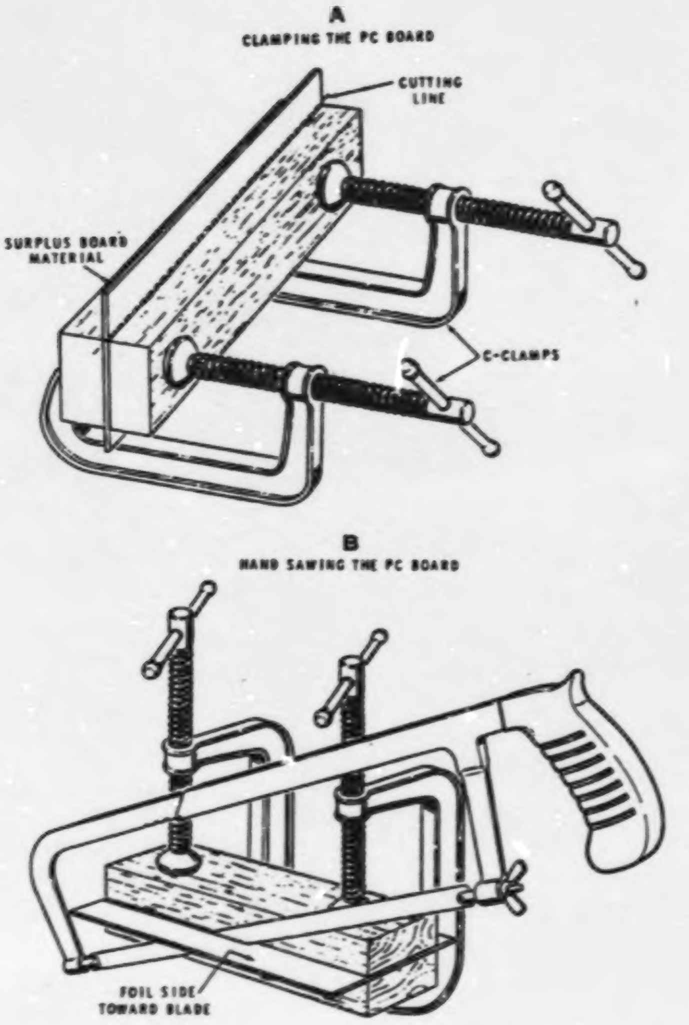
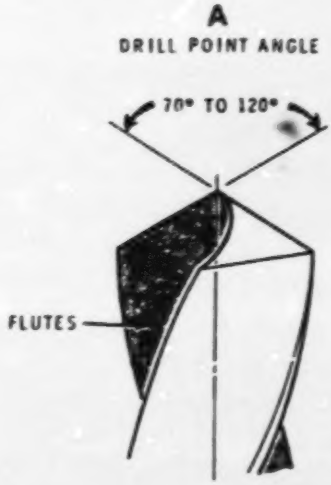
Methods of exposing photo-sensitized circuit board.


A
CLAMPING THE PC BOARD

B
HAND SAWING THE PC BOARD

Handsawing PC boards.


A
DRILL POINT ANGLE

B
RPM GUIDE FOR DRILLING 1/16 INCH PC BOARD MATERIALS

DRILL SIZE	SPEED (rpm)
No. 70	5000
No. 65	5000
No. 60	5000
1/16 inch	5000
1/8 inch	3000
3/16 inch	2500
1/4 inch	1700
5/16 inch	1300
7/16 inch	600

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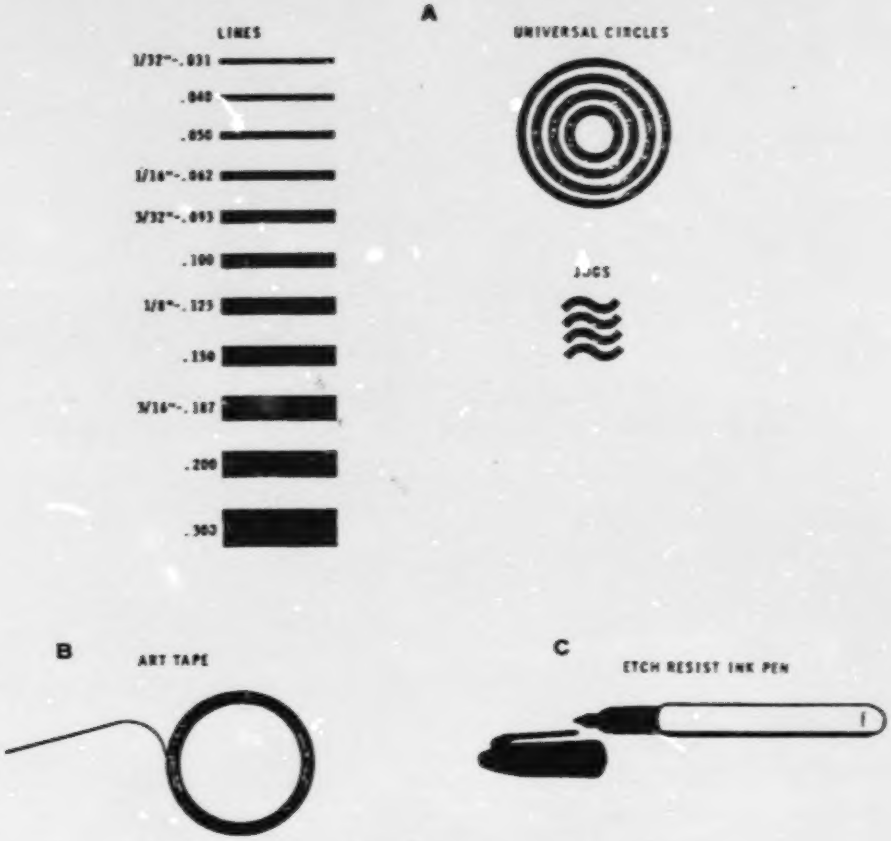
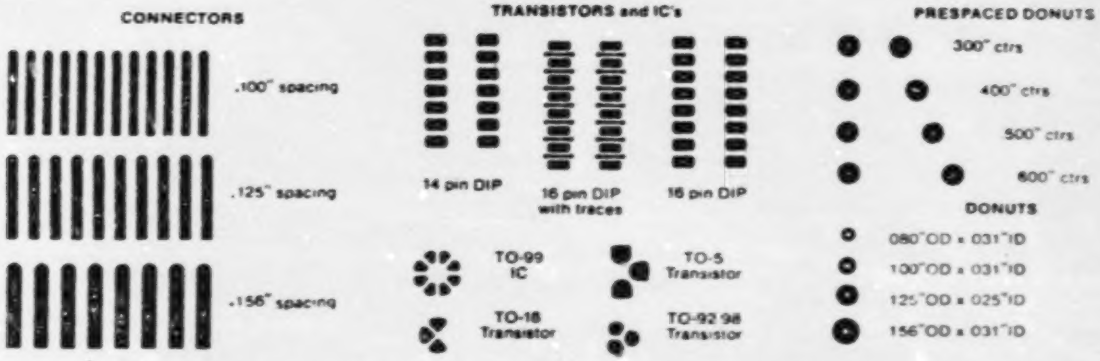


Design aids for making circuit board conductors.
(Courtesy of THE DATAK CORPORATION)



Dry transfer design aids.
(Courtesy of THE DATAK CORPORATION)

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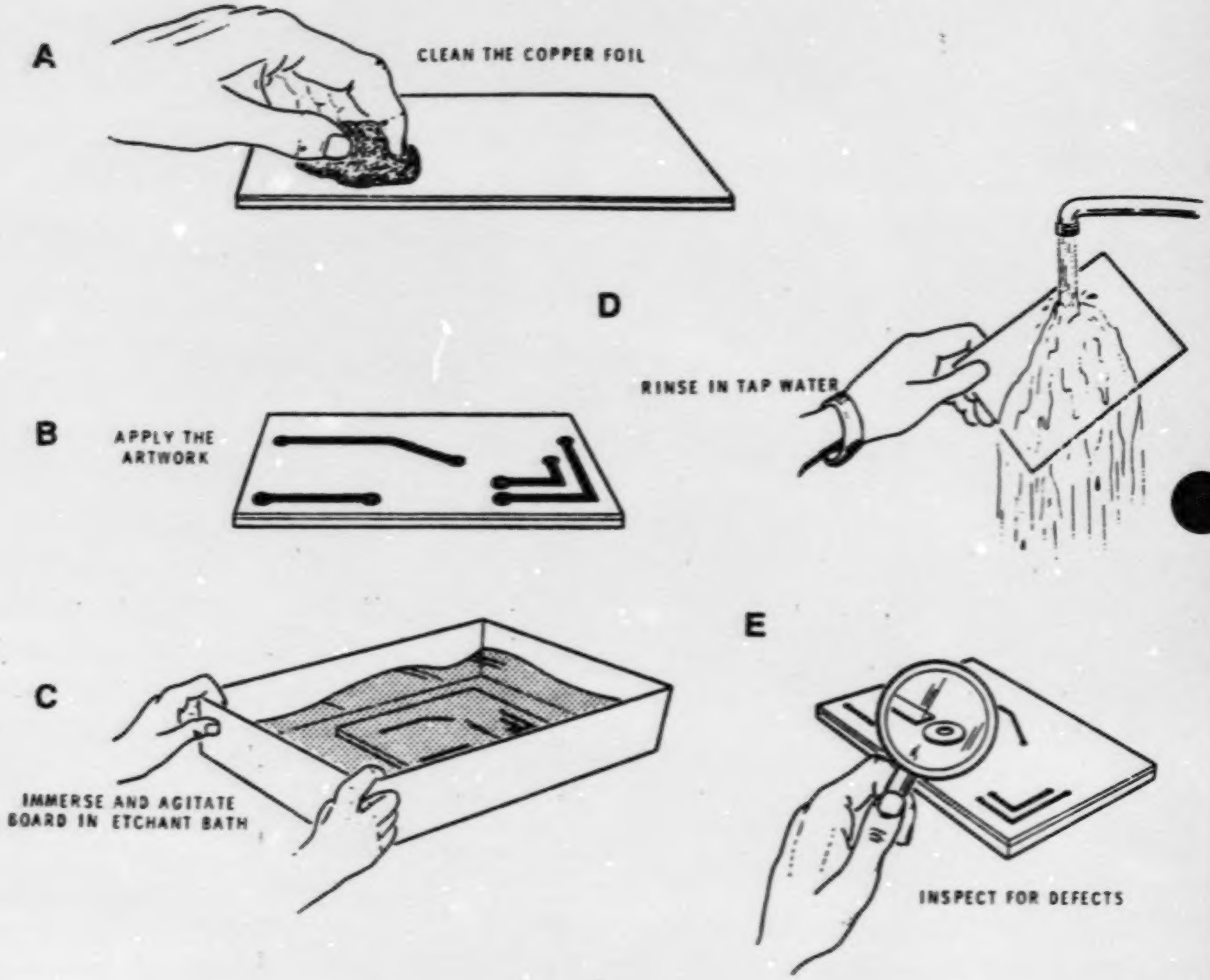

Direct pattern etching process.

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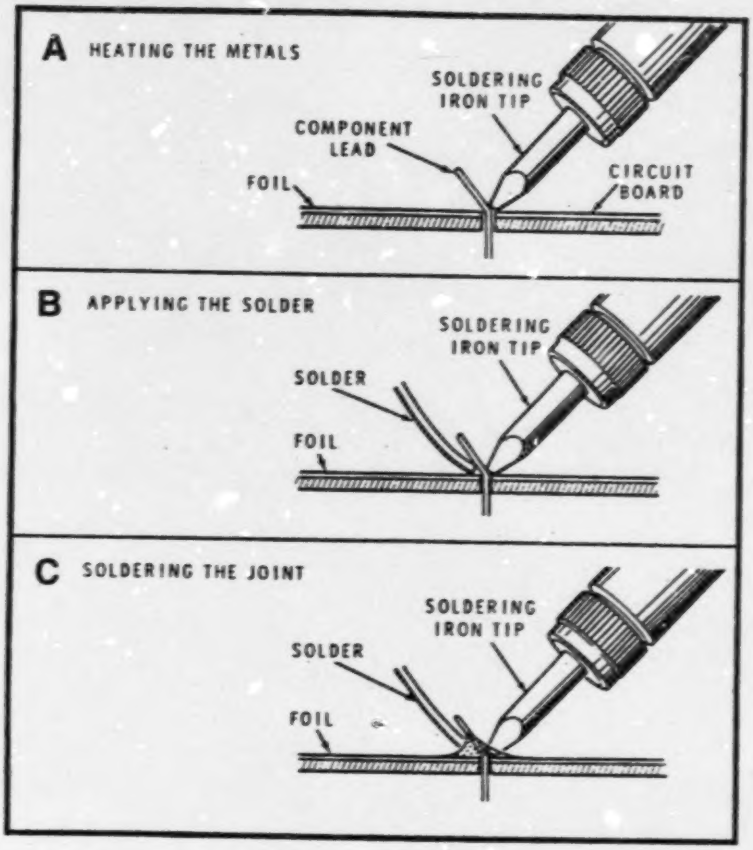
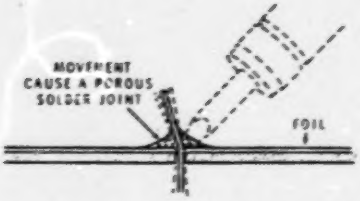
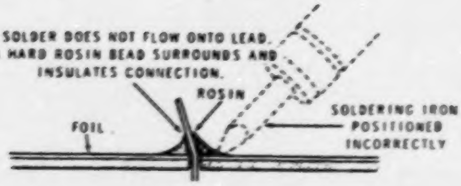
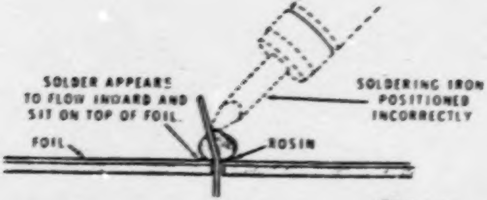
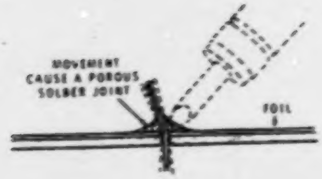
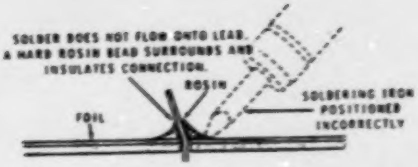


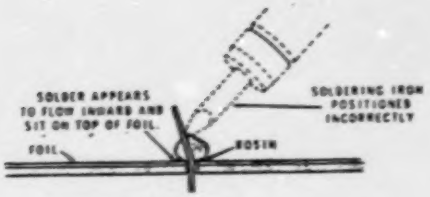


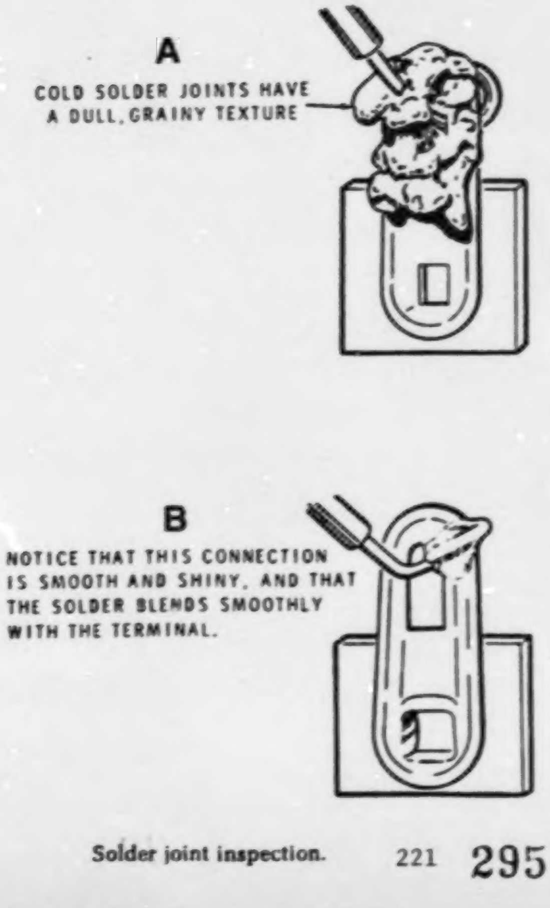

SOLDER DOES NOT FLOW ONTO LEAD. A HARD ROSIN BEAD SURROUNDS AND INSULATES CONNECTION.
ROSIN
FOIL
SOLDERING IRON POSITIONED INCORRECTLY


SOLDER APPEARS TO FLOW INWARD AND SIT ON TOP OF FOIL.
FOIL
ROSIN
SOLDERING IRON POSITIONED INCORRECTLY








A
COLD SOLDER JOINTS HAVE
A DULL, GRAINY TEXTURE
B
NOTICE THAT THIS CONNECTION
IS SMOOTH AND SHINY, AND THAT
THE SOLDER BLENDS SMOOTHLY
WITH THE TERMINAL.

Solder joint inspection.

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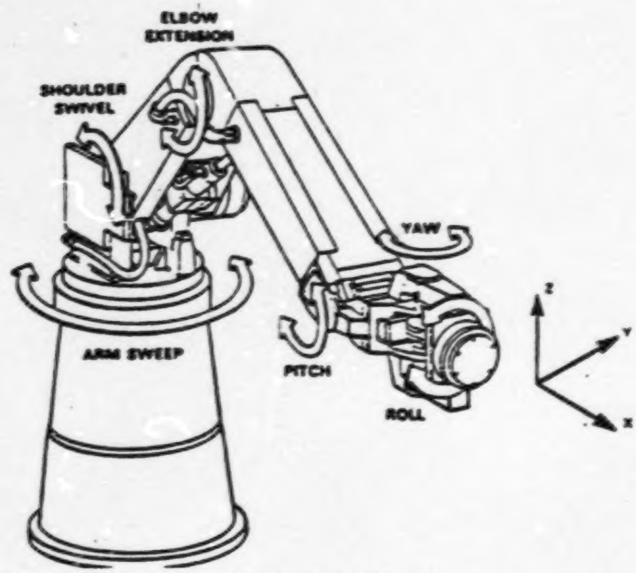
APPENDIX 14

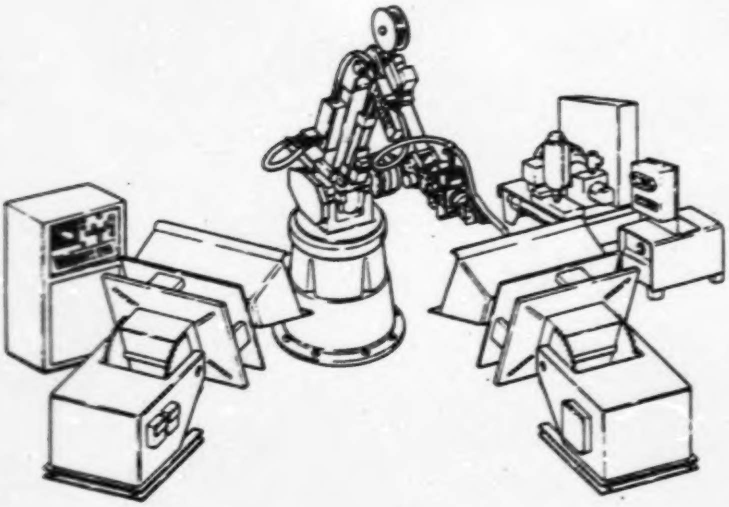
ROBOTICS



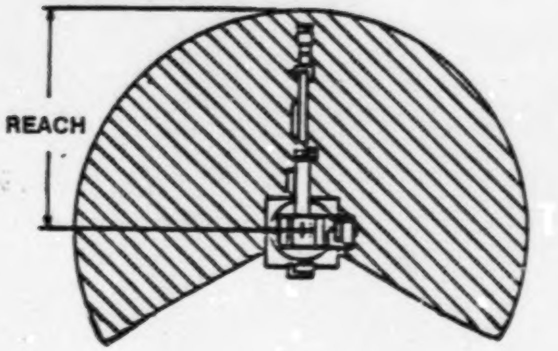
Mechanical Configuration and Coordinate System

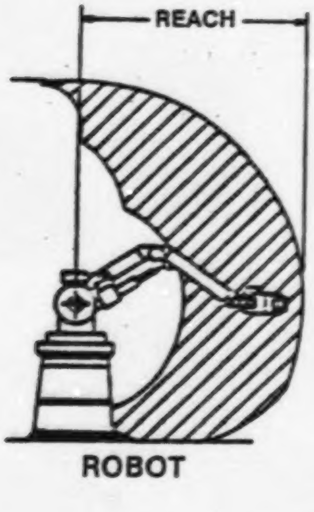
(Courtesy Cincinnati Milacron, Lebanon, Ohio)

ROBOT ARC WELDING SYSTEM

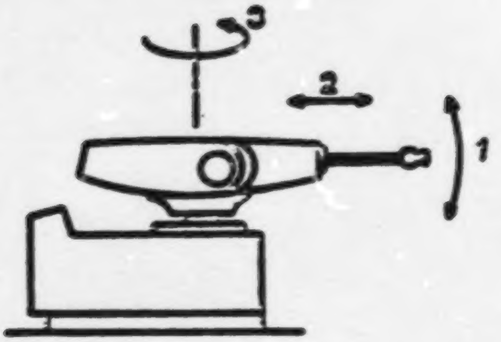


(Courtesy Cincinnati Milacron, Lebanon, Ohio)



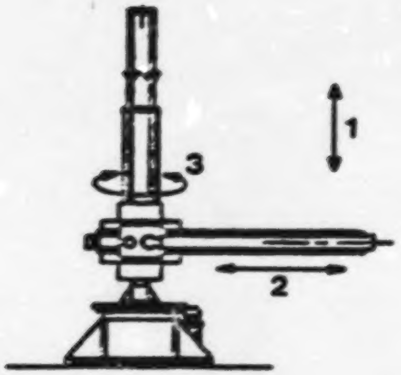


(Courtesy Robot Systems, Inc., Norcross, GA)



SPHERICAL COORDINATE

(Courtesy Unimation Incorporated, Danbury, CT)



CYLINDRICAL COORDINATE

(Courtesy Prab Robots, Inc., Kalamazoo, Michigan)

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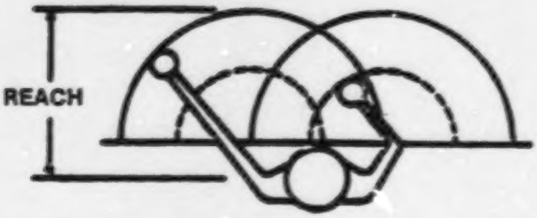
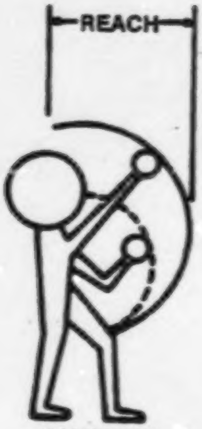
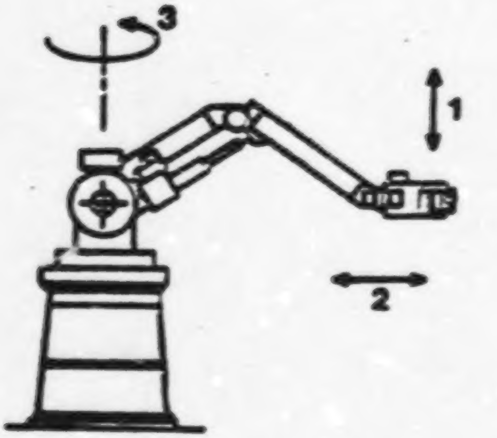




HUMAN

(Courtesy Robot Systems, Inc., Norcross, GA)



JOINTED ARM 300

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(Courtesy Cincinnati Milacron, Lebanon, Ohio)

APPENDIX 15

BODY EFFECTS OF CURRENT

Body Effects on Current

Current and its effects on the human body at 120V, 60 hertz (cycle):

.0005 or less amperes -- no sensation

.0005 to .002 amperes -- threshold of perception

.002 to .010 amperes -- muscular contraction (mild to strong)

.005 to .025 amperes -- painful shock, inability to let go

.025 to .050 amperes -- violent muscular contraction

.050 to .200 amperes -- ventricular fibrillation (convulsive movement of the heart - fatal)

over .100 amperes -- paralysis of breathing (apply artificial respiration immediately)

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